Vol. XXXI. August, 1906. No. 2.

MUNICIPAL ENGINEERING

A MONTHLY MAGAZINE

DEVOTED TO THE IMPROVEMENT OF CITIES

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PUBLISHED BY
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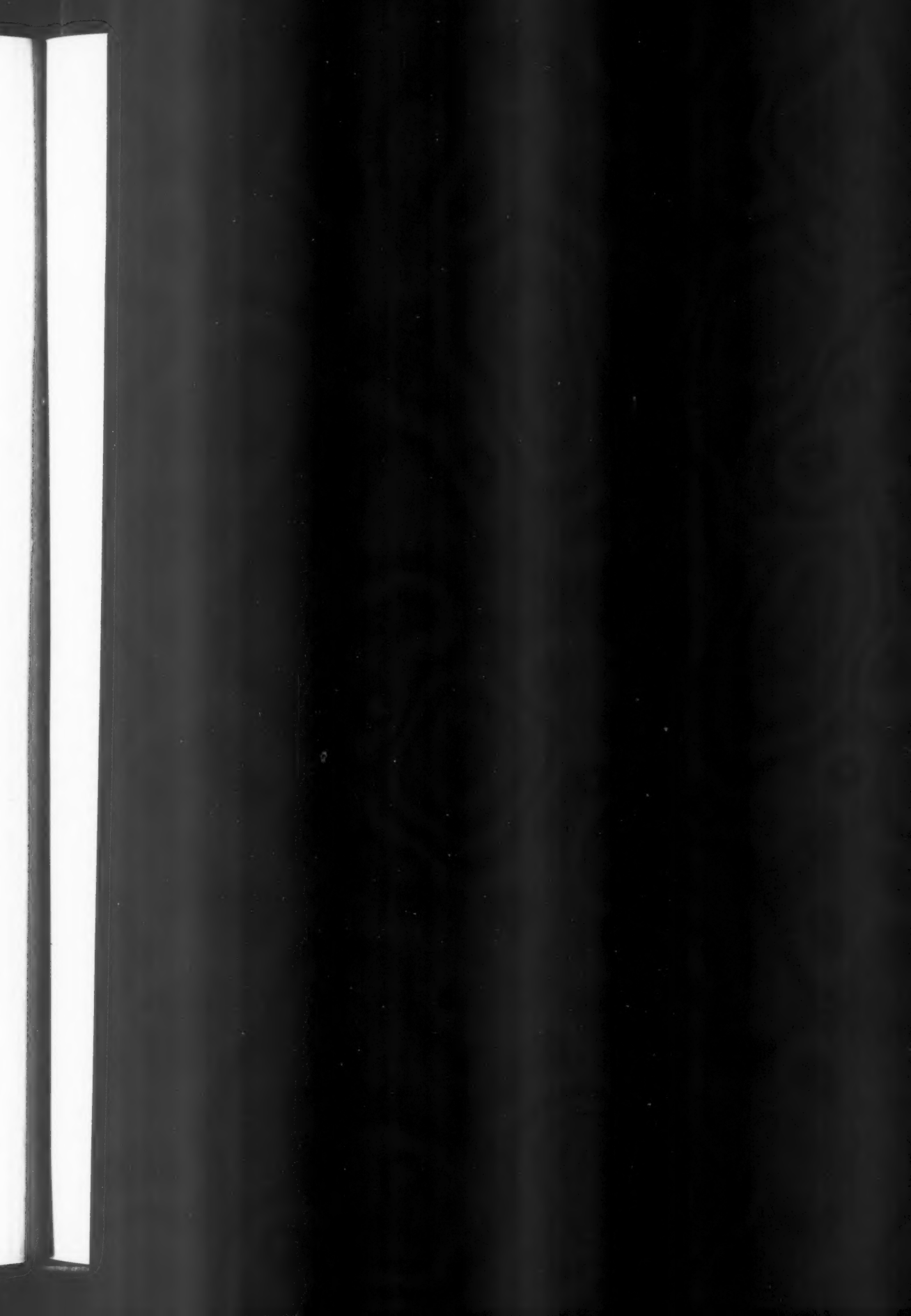


MUNICIPAL ENGINEERING

VOLUME XXXI. AUGUST, NINETEEN HUNDRED SIX. NUMBER TWO.

TARRED MACADAM HIGHWAYS.

The desirability of devising some method of constructing county highways so that the expense of maintenance will be reduced is shown by the following extract from an article in the New York *Tri-Weekly Tribune*:

Last November the voters of the state of New York carried, by a large majority, an amendment to the constitution providing for the expenditure of $50,000,000 for the improvement and maintenance of the public highways during the next ten years, at the rate of $5,000,000 a year. The last session of the legislature appropriated the sum for the first year, which will be expended by the state engineer's department during the current season.

When such a large sum of money is to be expended annually it is of the utmost importance that every dollar should be made to go as far as possible; that waste or loss, whether from negligence, ignorance or graft, should be reduced to the minimum, and eliminated wholly if possible; and that the best kind of road material should be used, from the standpoint of first cost, expense of annual maintenance and durability.

The present methods employed by the state in the construction of roadways are, undoubtedly, up to date for macadam construction. But the first cost is so great and the amount needed for annual maintenance so large that some other type of roadway should be devised, for the sake of economy. County Engineer McClintock, of Monroe, is the authority for the statement that the estimated cost a mile for maintenance of New York state roads for the current year is $310, which is an average cost of $0.063 a square yard. He also states that the 87.77 miles of macadam road built in Monroe county have cost $713,169.90, or an average of $8,114 a mile. The average cost of repairs for 1905 was $175 a mile. Notwithstanding this, it will cost $60,000 to put these roads in first-class shape, which is Mr. McClintock's estimate after a careful inspection of the roads last April. This is at the rate of nearly $700 a mile. The county engineer of Erie county reports that his county has made a contract for five years' repairs of its fifty-nine miles of macadam roads at the rate of about $400 a mile. The county engineer of Orange county said that the average cost of repairs of the 105 miles of road in his county for 1905 amounted to $415 a mile. In view of these facts it behooves the state engineer to find some more economical method of road building.

The state of New Jersey is reported to be experimenting with high grades of natural asphalt in perfecting a better type of road improvement. That an asphaltic macadam composed of trap rock of about the size now used for the ordinary macadam and high grade natural asphalts can be laid at a sufficiently low cost to be adopted for the improvement of public highways there is little doubt. All that is needed is the initial expense involved in experimenting.

The late Fred J. Warren, early in the development of his bituminous macadam, made a lot of experiments for the purpose of showing the feasibility of employing his methods of road construction for the public highway, and he found that such a road could be built for from 80 cents to $1 a square yard.

Experiments upon the use of tar for treating macadam roads were begun in France in 1896, and the reports of the road engineers call attention to the reduction in maintenance cost and doubling of life of roads so treated. One estimates that the "tarring resulted in an annual economy of 25 per cent." Another says:

"We have tarred a newly paved town street, renewing the layer every two years. The road is in an excellent condition just as level as when new, and instead of repaving the same at the end of five years as we used to do, we expect to repave the road at the end of ten or twelve years. In any case the condition of the road permits us to guarantee absolutely that the pavement will last twice as long when tarred."

Another report states that the "extinction of noise is still observed six years after treatment on a road which has been treated but once and where there is no longer any trace of the operation."

The United States consul at Marseilles says: "Tar applications are valuable in proportion to the excellence of the surfaces upon which they are laid. When well done the tarring gives the effect of an asphalt pavement and the foothold on a macadamized surface is, of course, much better than on asphalt."

Reports of experiments made in this

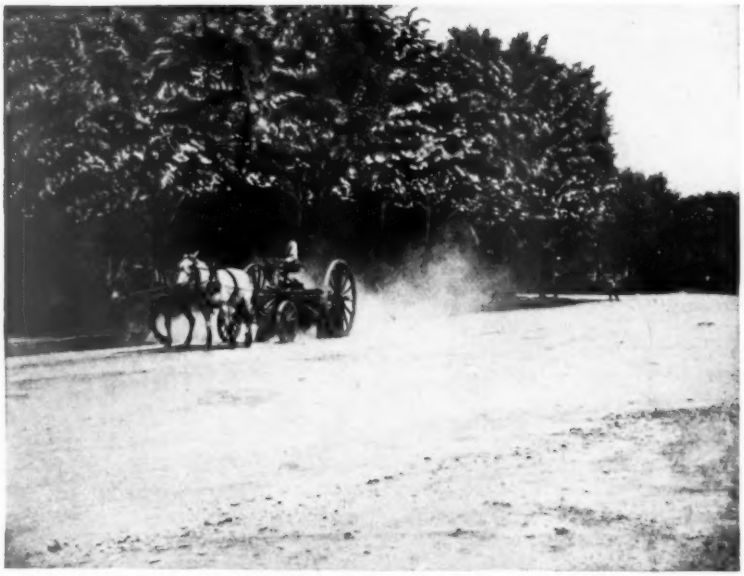
country in 1903 and 1904 in Westfield and Montclair, N. J., have been made. Regarding the latter the town council says: "This is a steep street with heavy traffic, and thus far, it not only stands the heavy traffic without wear, but is always clean and free from dust. Our opinion is that it will be very desirable to treat more streets next year with tar, taking those which are in good order, and using the tar principally as a means of preventing dust." The superintendent of roads and sewers reports that a tarred road, even after fifteen months of use, is not injured by water, wind or heat. It has also been used on heavy grades where practically the entire output of a large stone-crushing plant passes over it, making a very severe test, and after three months' use nothing has developed to indicate that even under these conditions it will not give equally good results. The walks and drives of the new park will be treated with tar.

W. H. Merkel, chief forester and constructor of the New York Zoological park, better known as the Bronx park, says: "At any season of the year the tarred and untarred roads and walks are easily distinguished, as mud and dust are impossible upon the former. The cost of the tarred surface is of course a trifle higher, but as it never has to be sprinkled, this extra cost is saved during the first summer."

The accompanying pictures, for which we are indebted to the Barrett Manufacturing Co., manufacturers of a special kind of tar for treatment of macadam roads, illustrate the methods of preparing and treating roads and the results of the treatment. The first cut shows the effect of an automobile in removing the surface of the untreated road by kicking up the dust through the action of its driving wheels and of the air currents it produces, thus wearing out the road and with the aid of the wind removing the worn particles and producing a nuisance with them. The following cuts illustrate the processes of treatment in order. The road must be very dry and all dust should be carefully swept up and removed. If a rain interrupts the process at any time work should not again begin until the road is thoroughly dry. The tar is then applied hot, so that it will be liquid enough to percolate some distance into the macadam. A slotted sprinkler is shown in one of the cuts, distributing the tar. The road is left standing a few hours for the tar to find its way down, the collections of tar in low spots being brushed out evenly with a broom. The roadway is then covered with a thin layer of fine, clean stone screenings, only sufficient to take up the surplus tar remaining on the surface. Two of the cuts show the spreading of these screenings. The road is then thoroughly rolled with a heavy steam roller and is ready for traffic. The last cut shows the completed street.

A DUSTY MACADAM ROADWAY.

It is stated that a proper treatment of a road can be made with 1-4 to 1-2 gal-



SWEEPING MACADAM ROAD PREPARATORY TO TAR TREATMENT.

SPRINKLING TAR ON MACADAM WITH SLOTTED SPRINKLER.

lon of tar per square yard, according to the density of the road surface and the temperature. The cost of the labor of sweeping, applying tar, spreading screenings and rolling is a little less than one cent a square yard. Adding the cost of the screenings, the total cost varies from 3 to 4 cents a square yard, or about $400 a mile of 16-foot roadway.

PURIFICATION OF SLAUGHTER-HOUSE REFUSE AT ZERBST, GERMANY.

By Wm. H. Schladitz, Mech. and San. Eng., New York City.

Because of the public attention which has recently been directed to the unsanitary conditions which prevail in many slaughter houses and the consequent thorough government inspection of these plants, it may not be amiss to call attention here to the careful and sanitary manner in which the disposal and purification of a slaughter house waste is carried on in Germany, where, as we all know, the government has succeeded in creating healthy and sanitary conditions.

The sewage and refuse water disposal and purification plant at Zerbst consists of three parts essentially:

1. The preparatory mechanical treatment.

2. The subsequent bacterial treatment in septic tanks.

3. The final bacterial treatment in percolating filters.

All refuse waters of any kind, i. e., domestic sewage, drainage from stalls, slaughtering pens and wash waters, etc., are led to and treated in this plant.

1. The preparatory mechanical treatment is performed in a special tank by means of grates and wire sluice baskets, with meshes of such a size as to catch all mechanical and inorganic impurities, also bones, pieces of meat, large pieces of fat, etc., which happen to be washed into the slaughter house gutters, and drain to the plant. The refuse waters subsequently pass three iron grates with openings of different sizes, first the one with the widest opening and finally two wire sluice baskets, arranged alongside of each other. All grates and wire baskets are arranged so that they can be easily taken out and cleaned.

After passing through grates and sluice baskets, larger solid suspended matters are eliminated, but the refuse waters contain still a large amount of liquid fat.

To extract this as far as possible, a series of cast iron plates are arranged in another special tank similar to the curtain walls and weirs, so that the fat of the warm refuse water is cooled off by flowing against them or over them, and thereupon sticks to the plates, the more, the cooler the water becomes. Part of the fat is crystallized and rises to the top. These iron plates can also be taken out for cleaning and replaced by clean plates, two or three sets being provided.

2. Septic Tanks.—After the preparatory mechanical cleaning the refuse water is of such a character as to be successfully treated in the septic tanks.

These tanks are large enough to receive several days' flow, as the concentration of the refuse water is very high, and a successful treatment only possible by protracted bacterial fermentation in the septic tanks.

The septic tanks are of the usual design, four in number and built of concrete, below ground and water-tight.

These four tanks are so arranged that they can be used independently or in series.

A vent duct takes care of gases which develop more or less in the tanks and leads them into a nearby chimney, thus preventing any molestation of the people living nearby.

3. Final Treatment in Bacterial or Percolating or Sprinkling Filters (coke tower).—From the last septic tank the refuse, which is now completely fermented and liquefied, flows into a storage basin; a steam pump lifts it on top of the percolating filter, where revolving sprinklers of copper carefully distribute it over the filtering medium, in this case a hard blast-furnace coke.

This filter or sprinkler tower is equipped with a very efficient aeration system, which permits ready access of air to all parts of the coke, thus maintaining a very energetic aerobic action upon the septic tank effluent.

About fifteen minutes are required for the septic tank effluent to percolate through the coke, from the sprinkler at the top of the tower to the outlet at the bottom, where a special control basin is provided, and where samples can be taken for purposes of analysis, etc. This control basin can be used also as a disinfecting chamber if required.

Owing to the concentration of the refuse water, the large amount of fatty and organic substances suspended, and

SPREADING TAR ON MACADAM.

TAR SPREAD ON MACADAM READY FOR COAT OF SCREENINGS.

also that cold weather prevailed when the plant was put in operation, hindering bacterial action, it was expected that considerable time would be required for the plant to reach high efficiency. Although the plant was put into operation at the end of March, 1905, only a few weeks later the results were very satisfactory. While the septic tank effluent was turbid and had naturally a distinctive foul smell, the coke tower effluent was very much clearer, with little smell, and contained only a small amount of suspended matter.

In order to exactly determine what progress the plant had made by May 8, 1905, i. e., five weeks after it was put into operation, Mr. Frederic Brettschneider, the manager of the F. W. Dittler company, the firm who designed and built this plant, took samples from the first and last septic tanks and the filter in the presence of the superintendent of the slaughter house and the city engineer.

These samples were taken in proper sample bottles, sealed and sent to Prof. Von Vogel, in Berlin, well known as an expert in all matters regarding sewage disposal and water purification, with the following request:

(a) Examine each effluent physically and then analyze.

(b) Report on the efficiency of the plant.

Prof. Dr. Vogel delivered his report on the 12th of May, and says in essential:

(a) Sample No. 1 from the first septic tank is a very ill-smelling foul liquid with great quantities of suspended solid matter, is of dark red color, apparently caused by large quantities of blood from the slaughtering. The suspended solid matters are typical for a slaughter house refuse water, i. e., they consist of undigested food, animal faeces, pieces of gut, bristles, hair, etc. At the same time, the whole was very fatty and oily. These solid suspended matters were easily to be separated from the rest by filtration. The sample contained at first very little organic suspended matter; after a while, however, a large quantity of unliquefied matter settled and the sample became turbid and the foul smell increased rapidly. Very obvious was the smell of the sample after concentrated cattle sewage. The color, which was first reddish, changed after a while into brown-red.

Sample No. 2 taken from the last septic tanks had a yellowish gray color, different from the first sample with the typical red coloring. It was very turbid but contained no larger pieces of solid suspended matter. The turbidity was caused by a small quantity of very finely suspended matter. The sample showed less of the suspended matter; it was, however, impossible to eliminate the suspended matters entirely by repeated filtration and impossible to obtain a perfectly clear filtrate. The color of the filtrate was yellowish, the smell of the sample, as well as that of the filtrate, was intensely foul, although the smell of cattle sewage, so typical for the first sample, was not noticeable.

Sample No. 3, from the percolating filter or coke tower, had a slightly yellowish color and was somewhat turbid, caused by very finely divided suspended matter. The quantity of the suspended matter was, however, very small. It was impossible to obtain a perfectly clear filtrate, as the suspended matter was so fine that it went through the filter. Sample as well as filtrate had very little smell.

The chemical analysis showed that sample No. 3, besides traces of nitric acid, contained large quantities of nitrous acid. Neither of these could be found in samples No. 1 and No. 2. The chemical analysis showed that a perfectly normal purification process takes place, as the sample No. 3 showed large quantities of oxidation products, which could not be found in samples 1 and 2.

ANALYSIS No. 1. (May 5, 1905.)

	Mgr. in liter.		Mgr. of permanganate of potassium with one liter.	Nitric acid.	Nitrous acid.	Sulphuric acid.
	Chlorine.	Ammonia.				
SAMPLE 1. First septic tank.....	85	80	670	0	0	Large quantities.
SAMPLE 2. Last septic tank.....	64	85	383	0	0	....
SAMPLE 3. Coke-tower effluent...	78	60	287	Traces.	Large quantities.	Still present in small quantities.

SPREADING SCREENINGS ON TREATED MACADAM SURFACE.

SPREADING SCREENINGS ON TREATED MACADAM SURFACE.

With reference to the above analyses, Prof. Dr. Vogel says: "The refuse waters from the municipal slaughter house at Zerbst are highly concentrated and overloaded with fermentable substances. These refuse waters received in the purification plant, as installed by the Dittler company, a very efficient preliminary mechanical treatment, which enables them to be treated successfully in the subsequent biological plant. The latter worked perfectly normal; of course, considering the short time of the operation of the plant at the time these first analyses were made, the degree of purification was not the highest possible and the effluent was not yet beyond criticism; nevertheless, the greatest part of the organic fermentable matter was eliminated and the high fermentability of ill-smelling refuse waters was reduced in the purification plant to such a degree that the coke tower effluent fermented very little and can be discharged without hesitation into any water course, a subsequent fermentation after a reasonable dilution with the water of same being entirely out of the question."

With reference to the efficiency of the plant, Prof. Dr. Vogel says: "In my opinion the waste water purification plant as installed at the municipal slaughter house in Zerbst is such that it meets every requirement. After it has been in use for a longer period the biological action will be complete. This can easily be seen from the present effluent, which is of such a character as to prove the efficiency of the plant without doubt.

This opinion of Dr. Vogel is thoroughly borne out by a subsequent analysis and report made on the 5th of September, 1905, i. e., after the plant in Zerbst had been four months in operation. The samples examined were the septic tank effluent and effluent from the percolating filter (coke tower). Prof. Dr. Vogel says in this report:

The septic tank effluent is of slightly yellowish color, very turbid, caused by large quanitites of very finely divided suspended matter. Larger pieces of suspended matter were not found. The filtrate showed some of the finely suspended matter of the sample and it was impossible to obtain a clear filtrate by repeated filtration. The color of the filtrate was slightly yellowish, smell distinctly foul of sample and filtrate.

Coke Tower Effluent.—The filter effluent from percolating filter (coke tower) was colorless and contained very small quantities of suspended matter. These were entirely eliminated in the filtrate, which was entirely colorless and odorless and looked like ordinary drinking water. The sample contained no foul smell whatever. A slight smell could be noticed as characteristic of water which stands a while.

The reaction of both samples was alkaline, that of the coke tower effluent less than the septic tank effluent.

CHEMICAL ANALYSIS No. 2. (September 5, 1905.)

	Mgr. in one liter.		Mgr. of permanganate of potassium used with one liter.	Nitric acid.	Nitrous acid.	Sulphuric acid.
	Chlorine.	Ammonia.				
Septic tank effluent...	71	120	403	0	0	Present.
Coke-tower effluent...	85	29	99	Much.	Much.	0

The results obtained in Zerbst prove that it is certainly possible, by means of a simple and comparatively inexpensive disposal and purification plant, to treat successfully slaughter house refuse and sewage and do away with the pollution of streams, lakes and bays which are in many instances used to dispose of these refuse waters.

In connection with this there should be noted also that the pollution of the streams and rivers by all sorts of factory refuse is practiced close at hand. It is not necessary to travel far from New York City to uncover conditions such as require treatment as described above. Any familiar with the conditions of the Passaic river will appreciate how the refuse of the factories along its banks has changed the river, by nature perfectly beautiful, into an open sewer.

ROLLING TREATED MACADAM ROADWAY.

FINISHED TARRED MACADAM ROADWAY.

A NEW SLOW SAND FILTER FOR LAWRENCE, MASS.

By J. Rodney Ball, C. E., Lawrence, Mass.

After four years delay, work has been begun upon a covered slow sand filter at Lawrence, Mass. The new filter will supplement the open filter now in use, the first one to be built after the evolution of the theory that polluted water could be adequately purified by means of a careful following of the natural laws in the formation of the filtering strata. The water supply of Lawrence is derived from the only available source, the Merrimack river, which, under the laws of the state of Massachusetts, still remains the sewer outlet for cities and towns inhabited by hundreds of thousands of people and situated between the City of Mills and the river's source.

The old open filter, built more or less as an experiment, has proven a success, and from an annual epidemic of typhoid fever, the scope of that dread disease has been limited to a remarkably small area. It has done most excellent work, and after twelve years' continual operation, it can produce, under favorable conditions, more than five million gallons of water in twenty-four hours.

Ice in winter and river silt in summer have greatly interfered with the most efficient work of the filter. During a cold winter season, it has been almost impossible to keep the galleries free from ice. As the ice increases in thickness, the filtering space decreases, and all means of aeration is cut off. At times there have been two feet of ice upon the filter, and the water in the reservoir has been so lowered in consequence that hardly a single day's supply has been available for the needs of a city of 70,000 people.

The city has grown since the plant was opened early in 1893, but the filter has remained in its original form, with the exception that its working has been facilitated by cutting it into three sections, by means of dividing walls, whereby two sections may be kept at work while the third is shut down for scraping.

Early in 1903, it was stated by those in authority that a new filter was a necessity, as the present one was not of sufficient capacity to supply the rapidly growing city and guarantee fire protection as well. Messrs. Chapin and Knowles, of Pittsburg, were engaged as engineers, and plans were drawn which were approved and accepted by the government.

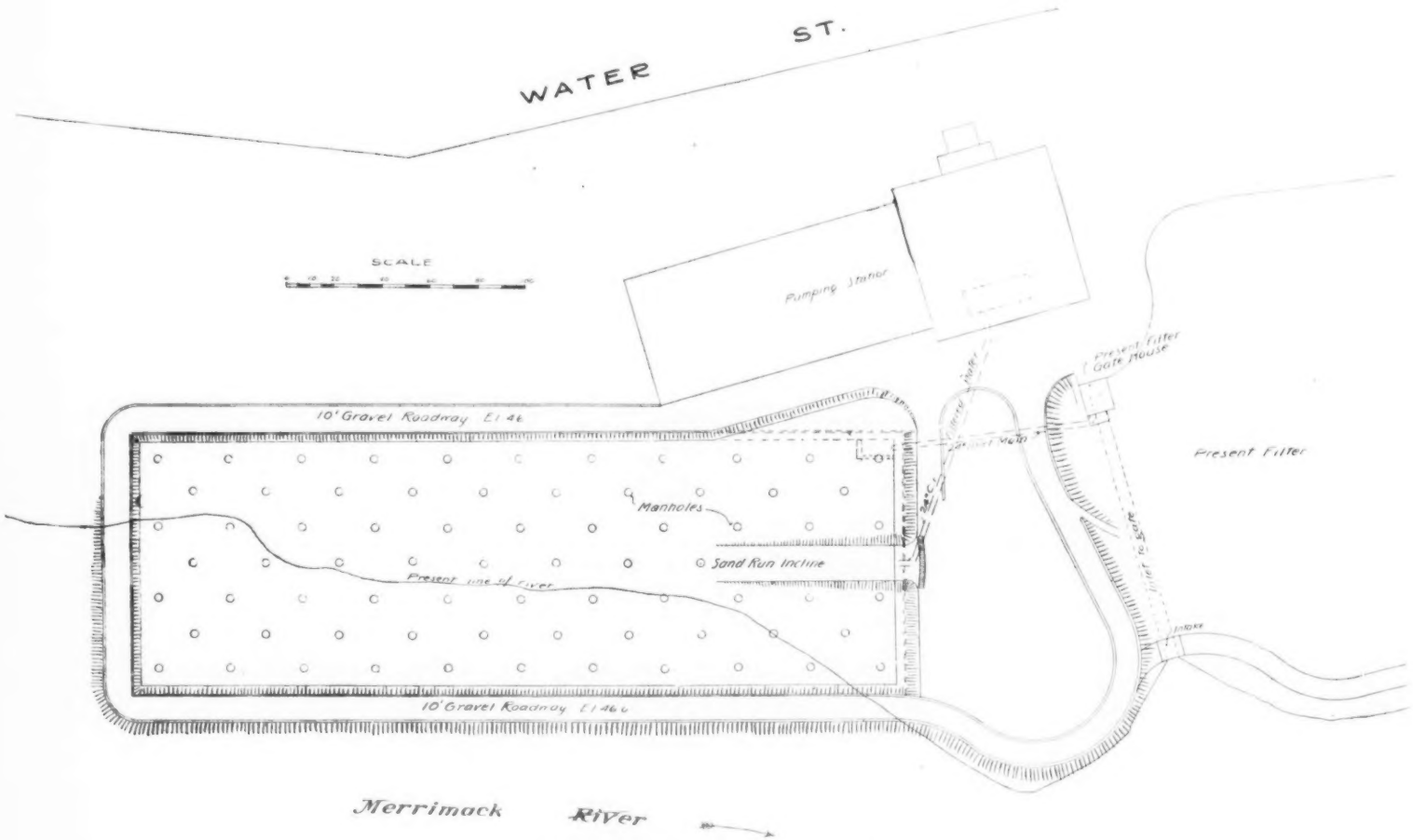
No appropriation was made for the work, however, and it went over into another year for the first active step. Nothing was done about it in 1904 until well into the fall, when it was too late to construct such a plant in time to be of any assistance, and yet it was realized that additional supply must be procured from some source. Appeals to surrounding towns were without effect, and then came the terrible winter, the most severe winter which the water department of the city of Lawrence ever had to contend with, and a time when a fire of any magnitude would have wiped out the entire available water supply.

The crisis did not come, and the dire extremity through which the city had passed was only realized by a few. The agitation was taken up again, but the people had come to the conclusion that they wanted water from some other source than that which was polluted by the sewage of a dozen cities. Lowell had found driven well water, so why not Lawrence, nine miles away? More than half a hundred tests were made in different localities, with varying success, but in no instance was water found in such quantity as would permit the state board of health to allow its use as an auxiliary supply.

The attention of the legislature was directed to the status of affairs, and this body ordered that additional supply be secured forthwith, but another year went by without the accomplishment of the mandate. Fortunately the winter which has just passed was at no time extreme, and there was no difficulty in keeping the galleries ice-free. The dire necessity had come to be realized, however, and in the early spring, with some additional prodding from the legislature, the government authorized the expenditure of $70,000 in the carrying out of the plans already held by the municipality.

Ground has been broken, and with the opening of another winter, the fears for an ample water supply for all needs and purposes will have been dispelled through the completion of one of the most complete filtration systems in the country.

The new filter will be located just west of the present open filter, extending some distance out into the river bed, and will be separated from the old plant by a depressed court with a granolithic pavement for the washing and storing of sand. In general design it will be similar to the filters at Albany, N. Y., and Philadelphia, Pa., with floor, walls and vaulting of concrete. The filter will be 313 feet long and



PLAN OF LAWRENCE, MASS., FILTER PLANT.

163 feet wide inside, and will give a net filtering area of about three-quarters of an acre.

The floor will be built in the form of inverted groined arches, six inches thick at the center, and fifteen inches thick under the piers. The concrete piers supporting the vaulting will be fifteen feet apart, center to center, and will be twenty-two inches square down to the sand line, from which point they will batter out to two feet, six inches at the base.

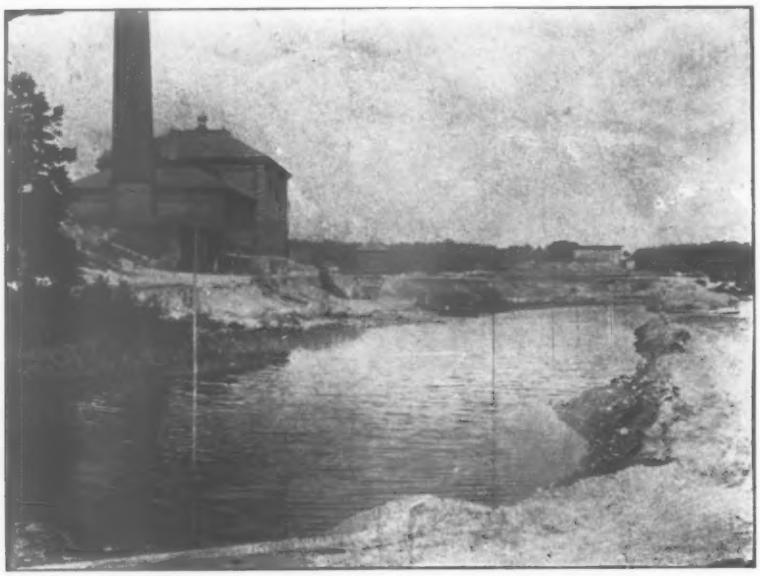
The outside walls will be twenty-four inches thick at the neat lines, with the outside batter varying from one in five to one in twelve, according to their position. The vaulting is to be constructed of concrete in the form of semi-elliptical arches, with a clear span of thirteen feet, two inches, a rise of two feet nine inches, six inches thick at the crown, and twenty-one inches thick over the piers. Ventilator openings will be provided for the admission of light and air during scraping.

On top of the vaulting, a layer of earth, three inches thick, will be placed, and turfed over. The filter and the court will be surrounded by a gravel road, ten feet wide and elevated above the level of the top of the filter and the court. At two points are sixteen-inch pipe drains to remove any surplus water from the roof of the filter, such as might be occasioned whether from heavy rains, or very high water in the river. Any water which may collect in the pockets over the piers will be taken care of by the two-inch agricultural tile pipes which enter the filter at the springing lines of the arches.

The filter will also be provided with a sand run entrance and incline, to allow going in and out of the plant for the purpose of removing or replacing sand.

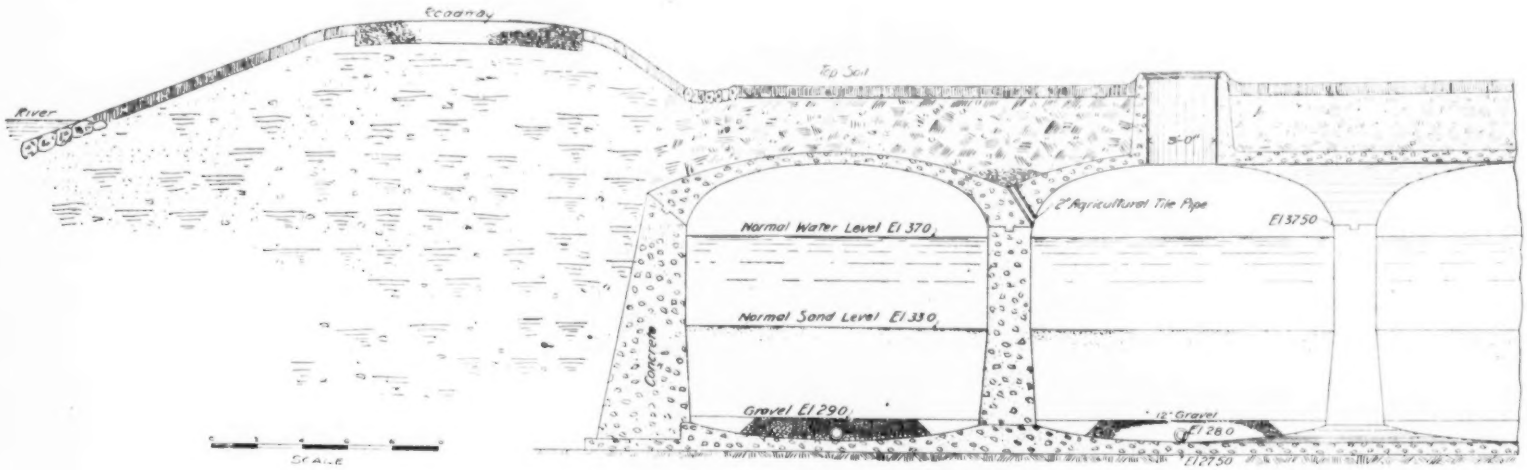
The underdrain system will consist of a concrete main collector, in the form of an arch above the general floor level, running the whole length of the filter, in the outer bay. This collector will be provided with three manholes to permit of entrance for cleaning, should occasion demand. From this main collector, the laterals will start out as twelve-inch terra cotta channel pipe, laid with open joints, and after running a distance of about fifteen feet, will be reduced to six-inch terra cotta pipe, also laid with open joints, extending to the center of the outside bay. The plans provide for a foot of gravel about the underdrains and four and one-half feet of filtering sand.

In the operation of the filter, the river water will be carried from the present gate house by gravity, through a twenty-four-inch cast iron pipe, to the inlet chamber in one corner of the filter, where the flow is to be regulated by a valve



LAWRENCE, MASS., FILTER PLANT SITE.

Pumping station at right. Gate house in middle background. Filter plant site in pond in foreground.



SECTION

LAWRENCE, MASS., FILTER PLANT.

of special design. The water will overflow the weirs in the walls of this chamber and will then be carried by open troughs down along the side walls of the filter. These troughs will be provided with orifices of varying sizes, according to their position in the filter, so that the inflowing water will be uniformly distributed over the whole area of the bed without disturbing the sand.

The water will then pass down through the sand and gravel into the laterals and by them will be carried to the main collector. Then passing out through a twenty-four-inch cast iron pipe, the water will flow into the pump wells of the pumping station, where the flow will be regulated by a float valve such as those in use at Albany and Philadelphia.

A STEEL ARCH HIGHWAY BRIDGE AT PITTSBURG, PA.

The artistic possibilities of an engineering structure, built with strict attention to the requirements of good engineering and with a minimum of effort toward ornamentation are shown by the Fern Hollow bridge in Pittsburg, Pa. The bridge is on a street opened a few years since between Pittsburg and Wilkinsburg and

ARCH HIGHWAY BRIDGE IN PITTSBURG, PA.

is over the gorge of the west branch of Nine-Mile run, the height of the floor being about 100 feet above the bottom of the valley. The sides of the gorge have steep earth and loose rock slopes covering the rock strata underneath and lend themselves readily to the form of structure decided upon, which is a circular arch with viaduct approaches, as shown by the accompanying photograph. The skewbacks for the arch are approximately parallel to the earth slopes, the radius and length of arc of the arch being so chosen that this happens, as well as that the crown of the arch reaches the roadway. The span of the arch is 195 feet, rise 50 feet, and the total length of the bridge is 450 feet.

There is a perceptible grade in the roadway, one end being about 15 feet lower than the other. This fact is partly hidden by making the posts supporting the viaduct approaches to the arch perpendicular to the line of the roadway, rather than vertical. This design also makes the posts appear to be vertical, whereas, the line of the roadway being the only line with which to compare them, the posts, if vertical, would appear to lean toward the high end of the bridge.

The bridge is located in a very picturesque district, near one of the cemeteries, and the street will probably be lined later with houses of a high class. But little view of the supporting arch and posts can be obtained and the railing is the only part of the bridge which the ordinary passerby can see. This railing is therefore made very substantial and elaborate and is the only part of the bridge

which there has been any attempt to ornament.

The general effect of the bridge from any point of view is distinctly pleasing and the ornamental railing fulfils the office of beautifying the roadway, as well as protecting the pedestrians from falling into the gorge. The only apparent incongruity is in the plain street railway poles and the method of supporting the trolley wires from them, which strike distinctly discordant notes.

The choice of material being necessarily for steel, on account of the limitations of the appropriation, the plate girder form of the arch rib was selected as showing most clearly the intent of the structure, and the three hinged type was selected as giving, on the whole, the least trouble with the roadway, which is of asphalt on a concrete foundation and therefore not to be subjected to very great variations in length on account of the movements of the arch on account of changes in temperature. The sidewalks, each 6 feet 6 inches wide, are of cement. Sidewalks and roadway are supported on buckle plates, which are in turn supported by the longitudinal and transverse girders and six lines of 12-inch I-beam stringers under the roadway and special channels and girders between the supporting brackets under the sidewalks. The roadway is 36 feet wide and the arch ribs are the same distance apart, thus necessitating the projecting brackets to carry the sidewalks and railings.

There is a double line of street railway tracks and the loads which the bridge is designed to carry are a street car weighing 30,000 pounds on two axles 7 1-2 feet apart on each track, a concentrated load on the roadway of 30,000 pounds on four wheels of 5 feet 3 inches gauge and 8 feet wheel base, and an evenly distributed load of 100 pounds per square foot on the sidewalk area.

Some of the dimensions of details are as follows:

Arch ribs are 6 feet 6 inches deep, web 3-8 inch thick, reinforced at necessary points, flange plates 20 inches wide. The posts carrying the floor system, each of two 15-inch channels, are in pairs, 24 feet apart, carrying 24-foot plate girders, 4 feet deep. The cross girders are 12 feet apart and 4 feet deep.

The quantities of materials used were as follows:

Stone masonry, 1,410 cubic yards.
Concrete, 287 cubic yards.
Steel, 1,457,000 pounds.
Railing, 889 feet, 60,000 pounds.
Asphalt paving, 1,800 square yards.
Sidewalks, 5,500 square feet.
Curb, 890 linear feet.

The total cost of the bridge was $86,534.

EDITORIAL COMMENT

Development of the Cement Industry.

Macadam Roads and Automobiles.

Sewage Pollution of Harbors.

DEVELOPMENT OF THE CEMENT INDUSTRY.

The fourth edition of the *Directory of American Cement Industries* will be issued a very few days after this number of MUNICIPAL ENGINEERING is read. It shows a large development in the industries using cement.

The increase in the production of cement has already been shown by the reports of the amount of cement manufactured in 1905, which have been published from time to time in this magazine. The increase for 1906 over 1905 will be quite as surprising as that of 1905 over 1904. The price of cement is such this year that every mill can make money and most mills can make large profits, and the demand for cement is so great that practically all the mills are running at their full capacity. The Directory shows numerous increases in capacity of existing mills and several new plants going into operation this year, or late last year, so that an estimate of an increase of more than 5,000,000 barrels in 1906 over 1905 seems moderate. This would make the domestic consumption of Portland cement, at least 40,000,000 barrels for this year, and the total consumption of cement over 45,000,000 barrels, or more than a half barrel for every man, woman and child in the United States.

The importation of cement fluctuates greatly with the market demands, the imports, after supplying a constant small demand, going to supply temporary deficiencies in local stocks. It will probably show some increase in 1906 over 1905, mainly on account of the special demand for the rebuilding of San Francisco, though some of this cement will not arrive in time to be counted in 1906.

The exportation of cement shows symptoms of increase, but so long as all the cement manufactured can be sold at home, dealers have little inducement to extend their trade to other countries and they are accused of neglecting these days foreign trade which they developed when there was a glut in the American cement market.

The uses of cement are extending rapidly and even if there should be a series of bad crops to offset the good years we have been enjoying, cement has found many places in which it will keep its hold and the reduction in the use of cement in such years will not be proportioned to the reduction in the amount of new work undertaken. In fact, the reduction in price which is inevitable when the demand for new work diminishes will actually increase the use of cement in such every-day structures as must go on in good or bad times.

The fears of overproduction of cement have some ground to stand on, but the industry seems now to have passed the period of great fluctuations, which every new industry of general distribution must experience and will now be subject only to the depressions to which the whole country is subject when crops are bad or speculation becomes too great and the reaction occurs.

The lists in the Directory give names of dealers in cement, of contractors and other purchasers of cement, of engineers and architects supervising its use, and all show the material extension of the uses of this modern building material. The list which shows the greatest extension is that of makers of artificial stone, which includes those who make cast stone, hollow blocks, solid blocks, posts, sidewalk blocks, or any movable article of cement made in a mold or machine. The list in the third edition was the first ever attempted and was made when the industry was just getting on its feet. This list shows the vigorous youth and, while it does not have every owner of a cement block making machine, it shows the wide extent of this industry. A study of the list will show where the machine sellers have been most active and where the undeveloped fields lie.

The other lists, laboratories, machinery makers and dealers, etc., keep up with the procession. Those who follow the lists of patents issued, which are published from month to month in the "Machinery and Trade" department of MUNICIPAL ENGINEERING, may have noticed the fact that on the average about one patent a week is issued for a block machine or mold of some sort. Such persons will not be surprised at the length of the list of machines and molds for making artificial stone, which includes only those which are really on the market.

The "Question Department" of MUNICIPAL ENGINEERING gives indications of the widespread interest in cement construction by the number and variety of questions and the many localities from which they come. Some localities are so interested that a question department in a local paper would be well patronized. The Minneapolis *Sunday Journal* runs such a column, and it is doing good educational work. One suggestion made in that column is for a practical training school for concrete workers, with the object of training workmen to fill the many vacancies which now exist, on account of the development of the demand for concrete work being more rapid than the preparation of men for taking care of it. Correspondence schools have been suggested, and even started, but they can scarcely meet the need, which is for practical cement workers. There are now too many men who know a little about how cement ought to be worked and are spoiling much good concrete from their lack of actual practical knowledge of how it can be worked. These schools must necessarily be somewhat local in character and there is room for one in every large city to serve the city and the district tributary to it. Such a school has been in contemplation in Indianapolis for a year and will probably be started by the Winona Technical Institute. Inquiries for the Indianapolis district may be directed to the Institute, and for the Minneapolis district to R. Taggart, Box 482. Perhaps the suggestion will start other school projects. Nothing will do more to develop the use of cement, for there is no greater need at the present time than for trained men to take charge of the practical work of making and placing concrete.

MACADAM ROADS AND AUTOMOBILES.

The use of automobiles has now been continued long enough to gain some idea of the effect of this kind of traffic upon roads and pavements. That it should be different from that of horse and horse-vehicle traffic was expected, but the early statements were to the effect that the rolling action of the rubber tires would be beneficial to the roads. Doubtless this is true for slow-moving vehicles, but the great power required to give the machine speed is exerted in the friction of the driving wheels upon the roadway and the result is the throwing up of the loose particles on the road surface and their removal from the roadway by this action and that of the wind. The result is a rapid wear of the road surface and a dust nuisance which becomes unbearable when the road is lined with houses. Sprinkling the road only partially remedies the difficulty and it is expensive and must be repeated several times a day. The suction effect of the rubber tires is even increased by wetting the surface.

In the article on "Tarred Macadam Highways," elsewhere in this number, the cost of repairs of the new good roads in New York is given and commented upon as too heavy, if any method of reducing it can be devised. How much of this heavy cost is due to the action of automobiles can not be estimated, for there were no state roads in New York before the development of automobiles to give figures of maintenance for comparison with the present cost.

What is needed is a surface for roadways subject to automobile traffic which will resist the removing action of the driving wheels. The ordinary hard pavements, stone, brick, asphalt, bitulithic, wood, are sufficient, but they are too expensive for country roads, except in the most thickly settled districts or where the property owners are wealthy. California uses oils with asphaltic base, and other districts where rains are not too frequent can do the same. Poossibly any district can use oil if great care is taken to have the road perfectly dry when the oil is applied. This condition limits tshe time during which work can be done on a road very materially. New Jersey towns and the United States Department of Agriculture in Tennessee have been experimenting with tar applied in somewhat similar manner, with results which are reported to be quite satisfactory. The suburban districts of Cleveland, O., are using brick pavements. Georgia has used some modified bitulithic pavement. All of these increase the cost of first construction, but the first two are reported to reduce the cost of maintenance to offset at least a part of the extra first cost. If cost of cleaning and sprinkling can also be considered, the oiled and tarred roads may very readily be found more economical than ordinary macadam.

The question now arises as to the proper placing of any excess of cost of these continuous road surfaces. There can be no doubt that a large part of the necessity for them is due to the use of automobiles. This is true both in country districts, where the ordinary traffic is light, and in suburban districts where the population is more dense and the traffic more continuous, since these roads are also the most frequented by automobilists. The farmer is begining to think that the increased cost of maintaining his roads should be assessed where it belongs, and that there should be some method of

placing it on the automobilists, for whom he has no kindly feelings for many other reasons. So long as roads are paid for or maintained by the township or county, it will be very difficult to reach automobilists with any license fee or assessment of tax, but in states having the state aid law for road building it should not be difficult to fix a license fee sufficient to place the added cost of the maintenance of roads on the new destroyers thereof. Data regarding the increase in expense are accumulating and give a basis for estimating the amount of tax necessary to recoup the state for the expenditures of the state, or its subordinate divisions for continuous surface roads, or the repair of macadam roads.

SEWAGE POLLUTION OF HARBORS.

As the great cities located on great harbors increase in size a time is reached at which the further discharge of sewage into the harbor begins to produce nuisances which cannot be ignored. For many years the amount of sewage bears so slight a ratio to the amount of sea water poured by the wharves and outlets of sewers that the pollution is not noticeable except in small bays and stagnant inlets where the sewer outlets have not been properly located, but ultimately the danger point is passed and the custom of the city must be changed.

The city of London has for some years partially purified its sewage and is now devising methods for still greater purification, the Thames being a comparatively small body of water into which to discharge the waste of so great a city. Manchester has spent some years installing a sewage purification system to prevent pollution of the river and the great ship canal.

New York city, notwithstanding the numerous inlets for clean water and its numerous tides, reached a few years ago the point at which sanitarians began to take notice of the effects of sewage and factory refuse pollutions of the waters of the harbor, and when several cities in the State of New Jersey proposed a joint sewer to drain into a rather unfavorably located part of the bay, the State appointed a New York Bay Pollution Commission, which reported adversely to the proposed works without previous sewage purifification, but could offer no plan for preventing the construction of the outlet if New Jersey decided to ignore the protest of the State of New York.

In the face of this report, the Bronx Valley Sewerage Commission has made a report recommending an outlet sewer for the territory in New York City and north of its limits and east of the Harlem railroad to discharge into the Hudson near Yonkers. The New York Bay Pollution Commission had also, on Aug. 1, 1905, passed the following resolutions:

Whereas, at a regularly called meeting of the New York Bay Pollution Commission, held August 1, 1905, it was brought to its attention that large sewerage systems are being planned to empty into the waters of New York harbor, or waters immediately tributary thereto, untreated sewage from non-riparian communities, it is

Resolved, That the commission considers that formal protest should be made against the discharge into New York bay or adjacent waters of any considerable amounts of untreated sewage from non-riparian communities of either New York or New Jersey; and be it further

Resolved, That copies of these resolutions be transmitted to the officials or boards responsible for such contemplated sewerage improvements and to the New York State Engineer and New York State Department of Health to the end that such contemplated systems may be provided with suitable purifying or disposal plants, so as to save free and harmless the waters of New York harbor from further sewage contamination.

This makes the action of the Bronx Valley Sewerage Commission still more objectionable, especially since the report makes no adequate argument for its position as opposed by that of the former commission.

However, a new Metropolitan Drainage Commission has been appointed to continue the study of the conditions of Greater New York regarding drainage, and as the Bronx sewer plans must be approved by the State Engineer and the State Board of Health before construction begins, the propriety of the plans will receive full consideration before much money is spent needlessly.

The case against the sewer outlet on the Hudson river is made stronger by the fact that the sewage has but one opportunity to reach the sea, and that on rising tides it must flow north before it flows south, and thus a less proportion of sewage is required to produce nuisance.

It will be necessary to have an interstate commission before the matter can be settled finally, the State of New Jersey being as great an offender as the upper districts of New York City and Westchester county and having quite as difficult sewerage problems awaiting early attention.

THE QUESTION DEPARTMENT

BOOK ON HIGHWAY BRIDGES.

About twelve years ago there was published a pamphlet on highway bridges for use of Commissioners' Courts, etc. Can you tell me where it can be obtained, or something similar, nothing technical.

A. M. F., Corpus Christi, Tex.

The pamphlet referred to is not known to the writer. Possibly Boller's "Practical Treatise on the Construction of Iron Highway Bridges" ($2) will serve the purpose. It is an old book and not altogether applicable to modern conditions, but it is not very technical and is apparently intended mainly for bridge committees.

CITY ENGINEER'S ESTIMATE OF COST OF WORK.

A question has arisen here as to whether an estimate worded "at a cost not to exceed $1.47 per square yard" is a legal estimate.

Don't confuse this with an itemized estimate of costs and quantities, but it is for the engineer's estimate on brick paving complete per square yard, according to specifications, which state all the details.

SAMUEL W. RAVENAL,
City Engineer, Boonville, Mo.

It may be assumed that the estimate referred to is that required by law in several States, which is the city engineer's judgment of the cost of the work, and in some States the work cannot be let at a figure higher than this cost, while in others ten per cent. leeway is permitted. Presumably the Missouri law is of this nature and the city engineer's estimate that the pavement will cost "not to exceed $1.47 per square yard" is his judgment of the cost and cannot be exceeded in the bids. Whether the exact form of statement of the estimate would be satisfactory to the court in case there were a controversy over the assessments is a question which could not be answered without knowing the ability of the judge to split hairs. It certainly expresses the spirit of the law and apparently conforms to its letter.

SPECIFICATIONS FOR BITHULITIC PAVEMENT IN INDIANAPOLIS.

We are preparing to use bitulithic pavement in an improvement we are going to make, and would thank you very much for the use of a copy of specifications used in your city for that pavement.

J. A. ZARING, Bedford, Ind.

Following is the specification for Warren's patent bitulithic pavement as adopted by the Board of Public Works for Northwestern and State avenues, Indianapolis. Only the specifications for the bitulithic portion are given, there being also general specifications and the specifications for other details, such as grading foundations, curb, etc.

1. Foundation.—Upon the sub-grade, prepared according to specifications for "Grading" (Form "K"), a concrete foundation shall be placed made in accordance with general specifications for concrete (Form "M"), except that the top surface shall be rough.

2. Wearing Surface.—On the rough surface of this proposed foundation shall be laid the wearing surface, which shall be composed of carefully selected, sound, hard, crushed stone, mixed with bitumen and laid as hereinafter specified. After heating the stone in a rotary mechanical dryer to a temperature of about 250 degrees F., it shall be elevated and passed through a rotary screen having six or more sections with varying sized openings, the maximum of which shall be 1¾ inches and the minimum 1-10 inch in diameter. The several sizes of stone thus separated by the screen sections shall pass into a bin containing six sections or compartments. From this bin the stone shall be drawn into a weigh box resting on a scale having seven beams. The stone from each bin shall be accurately weighed in the proportion which has been previously determined by laboratory tests to give the best results; that is, the most dense mixture of mineral aggregate, and one having inherent stability. From the weigh box each batch of mineral aggregate, composed of differing sizes accurately weighed as above, shall pass into a "twin pug" or other approved form of mixer. In this mixer shall be added a sufficient quantity of Warren's Puritan Brand No. 21 Bituminous Waterproof Cement to thoroughly coat all the particles of stone and to fill all voids in the mixture. The bituminous cement shall, before mixing with the stone, be heated to between 200 degrees and 250 degrees F. The amount used in each batch shall be accurately weighed and used in such proportion as has been previously determined by laboratory tests to give the best re-

sults and to fill the voids in the mineral aggregate. The mixing shall be continued until the combination is a uniform bituminous concrete. In this condition it shall be hauled to the street and there spread on the prepared foundation to such a depth that, after thorough compression with a steam road roller, it shall have a thickness of two (2) inches. The proportioning of the varying sizes of stone and the bituminous cement shall be such that the compressed mixture shall, as closely as practicable, have the density of solid stone.

3. Surface Finish.—After rolling the wearing surface, there shall be spread over it a thin coating of Warren's Quick-Drying Bituminous Flush Coat Composition, the purpose of this coating being to completely fill any unevenness or honeycomb which may appear in the surface of the mixture. There shall then be rolled into the surface a thin layer of stone chips, thus presenting a gritty surface and providing a good footing for horses.

3. General.—Each layer of the work shall be kept as free as possible from dirt, so that it will unite with the succeeding layer.

The bituminous composition or cement shall, in each case, be free from water, petroleum oil, water gas or process tars, and shall be especially refined with a view to removing the light oils, naphthalene, and other crystalline matter susceptible to atmospheric influences.

If the fine crushed stone used does not provide the best proportions of fine grained particles, such deficiency must be supplied by the use of not to exceed 15 per cent. hydraulic cement, pulverized stone, or fine sand or gravel.

PILE DRIVING FORMULA.

We are about to erect a warehouse building nine stories high, on a lot that has been filled (something like fifty years ago), with excavations from cellars, loam, sand and brick, rubbish containing little or nothing that is liable to disintegration.

This fill varies in depth from 6 feet to 16 feet. The underlying stratum is sand where fill is the least depth, and blue clay where fill is deepest.

Our maximum load is 1,500,000 pounds. Our minimum load is 600,000 pounds.

We are using in each group concrete taper piles, Raymond type, 20 inches at top and 6 inches at bottom, driven with a steam hammer weighing about 1,500 pounds.

What formula would you suggest to determine the bearing value of each pile? If you have not the information, can you refer us to authority or text books where it can be obtained?

W. H., Louisville, Ky.

The question of pile-driving formulas is discussed in the Transactions of the American Society of Civil Engineers, vol. xlii. Mr. C. H. Haswell, who has had much experience with pile driving, proposes a formula which, reduced to its lowest terms, is 32 times the weight of the ram in pounds times the square root of the height of its fall in feet, divided by a factor of safety of 3 to 6, according to the nature and condition of the soil, the character of the piles and the integrity of their driving. The result is the safe load in pounds.

The formula most commonly used is the Wellington formula, by which the extreme load on the pile is twice the weight of the ram in tons times the height of its fall in feet, divided by the depression by the last blow in feet plus 1.

The driving of piles is more a matter of judgment than of formula and several formulæ may be used to test the judgment until the engineer is reasonably sure of the correctness of his conclusions.

CONCRETE STREET CROSSINGS.

I would be glad to receive information on crossings for towns in regard to the thickness of the concrete course and top course.

E. R. BOWMAN,
Victor, Ia.

Street crossings of concrete are laid like cement sidewalks, specifications for which are given in this department on another page. The thickness of the base should be about 6 inches and of the top about 1½ inches.

SPECIFICATIONS FOR CEMENT STREET PAVEMENTS.

We are trying to introduce cement pavement and are seeking all the information to be had on this subject. Please send us the back numbers of your journal that contained the specifications for concrete pavement. Any arguments or suggestions pro or con will be appreciated. Can you recommend any publication or book devoted to this line?

T. C. S., ———, Ind. Ter.

The concrete pavements in Bellefontaine, O., laid about fifteen years ago, are described in MUNICIPAL ENGINEERING, vol. xvii, p. 383, and vol. xix, p. 427; those of Grand Rapids, Mich., in vol. xxiii, p. 400; those of Toronto, Ont., in vol. xxvii, p. 350; and those of Richmond, Ind., in vol. xxviii, p. 386. The first named are the only main streets paved with concrete. The other cities have used them only for narrow streets of light traffic, for which they seem to be quite satisfactory. They are durable and the most serious complaint made of them is that they are slippery. Bellefontaine laid its later streets in small blocks, in an attempt to obviate this difficulty, which was only partially successful.

The Handbook for Cement Users ($3) gives specifications for concrete streets and descriptions of still other pavements.

HOW TO BUILD A CISTERN IN WATER.

In answer to S. W. D., Mallard, Ia., page 21, July number. You can break the force of the water on your cistern by placing a sheet of waterproof felt over the bottom of and around the sides of your cistern on the outside of the brick lining and lay your brick up in mortar made 1 cement, ¼ hydraulic lime and 2 of sand, and plaster inside with 1 cement and 1 of fine but sharp clean sand.

H. H. GILLILAND, C. E.,
Indianola, Iowa.

PRICE OF CEMENT IN THE SOUTH.

We would like to know why it is that concrete workers up north and northwest can get cement for $1.50 and $1.60 per barrel, when down in this section it costs $2.30 and $2.38 per barrel, 7½ cents allowed for sacks returned.

GRANITEE STONE CO.,
Hazlehurst, Ga.

The freight rates on cement made north of the Ohio river and C. & O. railroad account for probably 25 cents of the difference in price, since the cement plants in the north are so generally distributed that freight rates at any one point of large consumption average between 5 and 12 cents a hundred pounds from the plants near enough to supply the market, while any large market for the highest grade of cements in the south must average from 20 to 35 cents a hundred pounds. Cement salesmen gravitate toward the largest markets, and those which take smaller amounts take what is left and at higher prices. Prices are higher in the north than those quoted, the present prices in Indiana being from $1.65 to $1.80. There remains 25 to 40 cents difference in price to be accounted for by the last reason suggested.

What can the cement salesmen say on the subject? Will a cement users' combination like those in the western states be necessary to bring southern prices to an equality with others?

COMPETENT CONCRETE WORKERS AND BLOCK LAYERS WANTED.

Can you refer us to some responsible contractor as near here as possible who will put up buildings from concrete blocks? One of the principal business blocks of this city burned out yesterday and the greater portion will be replaced at once with buildings built of blocks. We are engaged, as shown by card above, in the manufacture of blocks, and would want a man to take the contracts and use our blocks.

If you can also give us the names and addresses of responsible concrete workers who would not care to contract on their own account, but would work for us should we take a few contracts, you would be conferring a favor upon a subscriber.

R. B. C., ———, Neb.

The development of concrete as a building material has been so rapid that the supply of competent assistants has not kept up with it. The questions are referred to our readers for answer.

The block makers who do good work are very careful about the manner of laying blocks, and one has gone so far as to train up several men under his own instruction and to sell blocks only to those who will agree to employ these men to lay them. Brick layers and stone masons seem to start in with a prejudice against the blocks, which prevents them learning how to lay them properly, or they are too careless or indifferent to try to learn. While the brick and stone masons are contending over the new building material a new trade, that of cement block layers, can be developed by the cement block makers and users by a little judicious work.

The fourth edition of the "Directory of American Cement Industries" ($5), which will be issued in a very few days, contains lists of contractors, among which may be found some in the vicinity of our correspondent, who can and will undertake the work described.

HOW TO LAY A WIDE CEMENT PAVEMENT.

Kindly advise how your practical cement workers throw in a ten and twelve-foot wide pavement to make time. I have tried the one side at a time, also brought down both sides at a time. The double hardens too fast for the finisher, and the single makes a rough line when second side is brought along.

G. B. S., ———, W. Va.

Will our practical readers in cement pavement construction describe their methods of doing this work? The answers will be collected and published together, wiithout names if preferred. The employment of another finisher would seem to be the easiest way to make time.

MAKING PUMP PIT WATER TIGHT.

In addition to the answer on page 22 of the July number of MUNICIPAL ENGINEERING on making a pump pit water tight the Sandusky Portland Cement Company, Sandusky, O., refers to their Medusa waterproof compound, which was described on page 64 of the same number, and to the following letter regarding method of using:

We used your waterproof compound in building a basement and concrete floor in same.

The country in this vicinity is very flat, and therefore it has been considered impossible to build a basement that would be dry.

The work was done in very wet weather, this spring, and we were compelled to

pump the water out while putting in the cement floor.

Since putting it in it has shown no leaks and is perfectly dry.

We have had rain steadily since the evening of the 13th and our basement is as dry as a bone.

GRANT COUNTY LUMBER CO.,
Swayzee, Ind.

They also say that the city engineer at Akron, O., experimented with almost every known substance to overcome leaks in the reservoir in his city and finally obtained satisfactory results from the use of the Medusa compound.

SPECIFICATIONS FOR CEMENT WALKS.

We want good walks here and I am referred to you. We wish a strictly first-class specification with a very permanent wearing surface and in addition specifications for good ordinary walks. I desire further information with respect to cement. J. W. C., DeKalb, Ill.

Following are specifications for cement sidewalks originally prepared by the writer and slightly modified from year to year to correspond with changes in conditions. They are for good walks, and if specially durable wearing surface is required for very heavy traffic crushed granite of tough quality may be specified for part or all of the sand in the wearing surface.

1. Stakes will be set by the City Engineer to define the line of one edge of the walk, and the grade marks will indicate the top of the walk at said line. The transverse slope of the walk will be one-fourth inch per foot, and will be determined with level and grade board made according to the drawing in the City Engineer's office.

2. The sidewalk shall be graded to the width as shown on plan for the entire length of the improvement, including all wings and crossings as shown on plan, and sixteen inches below the finished surface of the walk. The grading must be smoothly and neatly done, all large stones, boulders, roots, sods and rubbish of every description being removed from the grade, and the entire work must be made to conform fully to the profile and the grade of the walk when finished. Soft, spongy or loamy spots in the sub-grade must be taken out and refilled with good material and the grade solidified by ramming.

3. Trees shall not be injured, cut down or otherwise disturbed except by order of the engineer. Roots of trees which are not removed, but which are contiguous to the line and grade of the walk or in any way interfere therewith, must be trimmed and cut away as the engineer may direct, and where the engineer directs the stones shall be fitted to the trees and the roots covered with earthenware half-pipes. Any tree removed must be grubbed for the entire width of the sidewalk and also all its roots that rise above the level of the sub-grade. No extra compensation for such work will be allowed.

4. Upon the sub-grade thus prepared and after inspection and acceptance of the same, a foundation of clean creek or pit sand and fine gravel, cinders or broken stone, in such proportions as, when rammed, will form a solid and compact mass, shall be spread to a uniform depth of twelve inches, all to be rammed and tamped until it presents a hard, smooth surface. It shall be sprinkled with water as required, enough remaining to render the surface as moist as the concrete at the time the latter is laid.

5. Wooden frames four inches in height will be placed in the manner necessary to outline both external edges of the walk accurately, the top of the frames being located to coincide with the established grade of the walk. Gauges must be used to render surface of foundation layer and of concrete parallel to the top of the walk. Concrete will be made as follows: One measure of Portland cement of the kind elsewhere specified for sidewalks, and two measures of clean, sharp sand shall be mixed thoroughly, while dry, ad then made into a mortar with the proper amount of water as determined by the engineer; broken stone or gravel not over one inch in any dimension, thoroughly cleansed from dirt and dust and drenched with water, but containing no loose water in the heap, will then be mixed immediately with the mortar in such quantities as will give a surplus of mortar when rammed. This proportion, when ascertained, will be regulated by measure. The engineer may accept a clean, natural mixture of sand and gravel if it is uniform and contains no dirt or other foreign matter, or stones larger than above specified. The proportions will be one part of cement to five parts of the mixture, to be mixed dry, the water being added afterward. Each batch of concrete will be thoroughly mixed, and the engineer may prescribe the number of times it shall be turned over, wet and dry, to accomplish this result. In general it shall be turned (or cut) four (4) times dry and three (3) times wet. It will then be spread to fill the frames even full and be at once compacted thoroughly by ramming until free mortar appears on the surface and until a one and one-fourth (1¼) inch gauge, furnished by the inspector, will pass over the concrete. It is the intention that the surface of the concrete, when thoroughly rammed, shall be at least one and one-fourth (1¼) inch below the top of the frame. The whole operation of mixing and laying each batch of concrete shall be performed as expeditiously as possible.

6. After each batch of concrete is laid, as required, it shall be immediately covered with the wearing surface. Any portion of the foundation which has been left long enough to have any appearance of setting, shall be taken up and relaid before the top is put on, and under no circumstances will concrete be allowed to remain over two hours before top is put on. The wearing surface or top shall be composed of five (5) parts of the same kind of cement in the concrete and seven (7) parts of clean, sharp, washed sand, thoroughly mixed dry and made into mortar with the proper amount of water as determined by the engineer. It shall be evenly and compactly spread to the finished surface of the walk and made smooth and even by troweling and floating. The top and concrete foundation shall be cut into blocks of dimensions approved by the engineer, forming an expansion joint between adjoining blocks. The pavement shall be properly fitted around all fixtures in the sidewalks, the edges of the pavement to be beveled from top surface to bottom of concrete with the material used on top.

7. Coloring matter of quality and quantity approved by the engineer will be required for the top surface. On business streets the engineer may require the surface to be carefully rolled with a toothed roller when the finish is completed.

8. Where walks of any description that now exist on the street shall be accepted by the Board of Public Works or the engineer, they shall be relaid if the engineer deems it necessary, to the grade and line established, and if the price therefor is not fixed in the contract it shall be determined by adding fifteen per cent. to the actual cost of the work as determined by the engineer. Similar procedure will be taken for the extra work in resetting area ways and similar structures to grade and line. When a driveway occurs in the line of the walk, the walk will be increased in thickness and laid according to plans furnished by the engineer, the additional expense to be paid by the owner.

9. The completed work shall be perfect and of good quality in all respects, free from cracks, warps, disfigurations and similar imperfections. Special care shall be taken to protect the walk at night. If found not to comply with the specifications in any respect at any time up to the end of the guarantee period, it shall be taken out immediately on the demand of the engineer and replaced by the contractor at his own expense.

10. A list of Portland cements, which have been tested in the laboratory and found satisfactory for use in the construction of cement sidewalks, will be found in the office of the City Engineer.

11. Embankments shall be formed of compact earth free from large stones or perishable materials, and shall be raised to such a height as to conform to the grade and line after such embankment shall have become well settled by proper tamping, ramming or rolling the same.

12. The lawns shall be graded to conform to walk and curb grades and dressed with fine earth, raked and left smooth. If sodding is specified the lawns shall be sodded with blue grass sod, free from weeds, and such as to meet the approval of the City Engineer. All joints shall be broken in laying and the sand shall be rolled to a uniform and even surface. The sodding must be kept sprinkled until such time as the entire improvement is accepted by the city.

If the lawns are already in grass they shall be left in proper condition satisfactory to the City Engineer, and any unnecessary damage shall be repaired. Traffic on the street must not be interfered with any more than is necessary, and the walk must be laid in sections which will interfere as little as possible with pedestrians. As soon as the walk has been completed in front of any lot, the contractor shall clean street in front of completed sidewalk of all surplus material, cement, sand, gravel, barrels, etc., used in its construction, and permanently improved streets shall be kept clean in front of completed sidewalk until accepted by the city.

13. See the General Specifications for guarantee in connection with cement walks.

The "Handbook for Cement Users" ($3) contains also the standard specifications used in many cities and much other information on the subject.

A well-laid cement walk is indestructible by weather and will stand much ill usage. It keeps its place, is not so quickly or seriously injured by slight washouts, is ordinarily of better appearance than other walks, is smoother and in the long run is more economical, though possibly more expensive at the beginning. One or two good cement walks in a town always lead to more, and a system of cement walks, laid to grades, of which a system should be established by a competent engineer for the whole town, will do more to beautify the town, by inducing lot and street lawn improvements, than anything else that can be carried through.

The "Handbook" will give information about selection of cements also. There are now many good brands of cement for sidewalks, but the cement offered should be tested unless one is sure that the contractor or dealer is furnishing the brand which he claims to offer and it is generally accepted as a first-class cement. even though the testing of small quantities is somewhat expensive and apparently needless.

PERMANENCE OF TIES IN TWO-PIECE BLOCK WALL.

I would like to ask you about the cement block building. We have a mechanic here, who makes a block in two parts, makes a hollow wall, and ties from one to the other with galvanized strips. Will these strips rust out and leave the walls untied? You will understand the inside wall is entirely separate from the outside wall. W. H., Riceville, Ia.

The galvanized iron strips should last indefinitely. Perhaps their life will be lengthened somewhat by dipping the strips in a very wet mixture of water and neat cement, or painting them with it, as a coating of cement is one of the best preservatives of iron or steel which is known.

CEMENT BLOCK FOR BLACKSMITH SHOP.

I have the prospect of building a blacksmith shop out of cement building blocks and party wants a good shop and does not want to put any extra money in it. It is for a country shop with two fires, and he thinks he will want to put the forge in the center of the shop. He thinks that he will want it 50x50 feet, one story high, and he is afraid of the cement roof and floors, and I wish to ask if it is practical to put a cement floor in it in the northern part of Iowa. He is afraid that ice will freeze on the floor and cause horses to slip; and is the matter of the roof practical for that size of building?

If you will insert this query in your magazine for replies by those who have had experience in the matter, you will confer a favor on a reader of your magazine. D. T. K., Hawarden, Ia.

This letter is printed with the request that our readers reply for publication. Their names will not be attached to the communications if they so request.

If the floor is kept too clean, water is

likely to freeze on it and increase its natural tendency to be slippery. But it is not hard to allow enough dirt to accumulate in such a shop to remove this objection. Cement floors in stables are usually provided with removable wooden platforms, on which the horses stand, but these are used mainly because the cement floor is too hard for horses to stand on constantly. This wooden floor might be used in case there is too much trouble for slipperiness, but will probably not be necessary.

A concrete roof of 50 feet span would be rather expensive, and one or two rows of posts as supports for it would be advisable, unless reduction in expense is not as important as clear space. The roof should be designed by a competent engineer, who can save his fee in selecting the most economical design.

THE ATLANTIC PORTLAND CEMENT COMPANY.

Do you know anything about the Atlantic Cement Co., of San Francisco, Cal.?
C. L. B., New York City.

Can you give us any information about the Atlantic Portland Cement Co. of Pennsylvania? B. V., New York City.

The new edition of the "Directory of American Cement Industries" ($5) gives information about the preliminary organization of the company. Since the pages containing this information went to press the following detailed information has been received from Dr. Irving A. Bachman, who was there given as the engineer of the company:

The Atlantic Portland Cement Co. has been incorporated with an authorized capitalization of $5,000,000, to build Portland cement works with a capacity of 6,000 barrels a day at Nazareth, Pa. The officers are William J. Dingee, president; Irving A. Bachman, vice-president; Frank A. Losh, secretary; the Crocker-Woolworth National bank, treasurer; all of San Francisco, Cal., with F. A. Morrison and Ed McGary as additional directors. Lewis H. Roseberry is superintendent. The plant will be a rotary kiln plant, with ball and tube mills for grinding, and will have 200,000 barrels of bulk storage capacity for finished cement.

METHOD OF STRIPPING CLAY FROM SAND BANK.

My sand is from 50 to 100 feet deep. On top of the sand the clay is from 20 to 75 feet deep. It is necessary, on account of price of sand in this vicinity, to find some very cheap way to handle the clay. Some have suggested water as the right thing, and I would like to consult with some one that has had experience in handling clay in this way. Can you refer me to such a party? Or is there a better way than this to do it? I have about 150,000 yards of clay to handle and a deep ditch is 700 feet away and 40 feet lower than the top of sand. Any information will be appreciated.
W. S. C., ———, Ia.

This is a problem for an engineer who can study it on the ground. It is evidently a question of comparative cost of getting the sand, for if the handling of the clay will add too much to the cost of handling the sand this bank can not compete with others more favorably situated. The amount of clay named is large and a large area or a river must be at hand into which to wash it if the hydraulic method is used. Reference may be made to the list of "Civil Engineers" under that heading in the "Business Directory," published in each number of MUNICIPAL ENGINEERING, for names of men competent to make a study of the problem and recommend a method of getting out the sand if one cheap enough can be found.

Our correspondent will doubtless welcome suggestions from any of our readers who have had similar problems.

CEMENT CHEMISTS.

Will you please give me the address of some one by whom I can have cement rock tested. C. C., Ottumwa, Ia.

Reference may be made for names of competent persons for this work to the "Business Directory," published in each number of MUNICIPAL ENGINEERING, under the headings, "Chemists, Cement," "Chemical Tests" and "Analyses."

SPRINKLING ASPHALT STREETS WITH SALT WATER.

Will you kindly let me know what effect, if any, salt water has on asphalt pavement? We are sprinkling our streets this season with sea water, which leaves, when evaporated, a coating of salt which is ground into the warm asphalt by the wheels of the wagons.

I find nothing in any of the works I have treating on this subject and would like to know if there has been any experimenting along this line and what the results are. H. J. BOSTIAN, C. E.,
Ballard, Wash.

In MUNICIPAL ENGINEERING, vol. xi, p. 309, and vol. xvi, p. 94, are statements that salt and salt water do not injure asphalt pavements. The question is largely a chemical one. Fresh water standing on asphalt pavements dissolves out soluble matters in the pavement mixture and also acts to some extent on some asphalts. Possibly sea water has the same effect upon some of the constituents of some paving mixtures, but thus far there have been no reports of serious effect. An examination by a chemist, or a test in the laboratory would give valuable information. Meanwhile the small amount of information available indicates that the use of salt water for sprinkling asphalt streets is safe.

CONCRETE

Reinforced Concrete—Sand for Mortar and Concrete.

Reinforced Concrete.*

BY WALTER LORING WEBB, PHILADELPHIA.

The justification of the use of reinforced concrete is usually based on some one or all of three conditions. First, under some circumstances it is actually more economical than any other rational method of construction. Secondly, there are cases where it is almost the only practicable method of construction. Thirdly, there are cases where it is simply preferable. It is not very easy to demonstrate the economy of this method except by comparative cost in individual cases, but an approach to a systematic comparison may be made as follows: A cubic foot of steel weighs 490 pounds. Assume as an average price that it can be bought and placed for 4.5 cents per pound. The steel will therefore cost $22.05 per cubic foot. On the basis that concrete may be placed for $6 per cubic yard, the concrete will cost 22 cents per cubic foot, which is 1 per cent. of the cost of the steel. Therefore, on this basis, if it is necessary to use as reinforcement an amount of steel whose volume is in excess of 1 per cent. of the additional concrete which would do the same work, there is no economy in the reinforcement, even though the reinforcement is justified on account of the other considerations. Assuming 500 pounds per square inch as the working compressive strength of concrete, and 16,000 pounds as the permissible stress in steel, it requires 3.125 per cent. of steel to furnish the same compressive stress as concrete. On the above basis of cost, the compression is evidently obtained much more cheaply in concrete than in steel—in fact, at less than one-third of the cost. On the other hand, even if we allow 50 pounds per square inch tension in the concrete and 16,000 pounds in the steel, it only requires 0.31 per cent. of steel to furnish the same strength as the concrete, which shows that, no matter what may be the variation in the comparative price of concrete and steel, steel always furnishes tension at a far cheaper price than concrete—on the above basis, at less than one-third of the cost. The practical meaning of this is, on the one hand, that a beam composed wholly of concrete is usually inadvisable, since its low tensile strength makes it uneconomical, if not actually impracticable, for it may be readily shown that, beyond a comparatively short span, a concrete beam will not support its own weight. On the other hand, on account of the cheaper compressive stress furnished by concrete, an all-steel beam is not so economical as a beam in which the concrete furnishes the compressive stress and the steel furnishes the tensile stress. This statement has been very frequently verified when comparing the cost of the construction of floors designed by using steel I-beams supporting a fireproof concrete floor, and that of a concrete floor having a similar floor slab, but making the beams as T-beams of reinforced concrete.

Another instance of the actual economy of this method of construction is furnished by a recent design for a retaining wall. The wall was to be 14 feet in height and the design was for a skeleton reinforced-concrete construction. It has a base-plate of the requisite width, so that the center of pressure of the base will be properly located. Buttresses which run back into the embankment at proper intervals are connected with the base-plate, while the face of the wall between the buttresses has only such thickness as is required to withstand the bursting pressure developed between each pair of buttresses. The whole structure is reinforced with steel so as to take up all the tensile stress which may be developed in any part of the wall. The cross-section of this wall has an average value of 25.44 square feet, which is the equivalent of 25.44 cubic feet per linear foot of wall. A wall of rubble masonry was designed by well-known railroad engineers for this same location. This wall had a cross-section of 80.45 feet. On the basis of 25 cents per cubic foot, or $6.75 per cubic yard, each linear foot of the rubble wall would cost $20.12. Of course, the unit price of the concrete wall is considerably higher, but its volume is but little over 30 per cent. of the volume of the stone wall. In this particular case an estimate for this wall at the rate of 40 cents per cubic foot as measured in place was

*From a paper before the Engineers' Club of Philadelphia.

obtained from a reliable contractor, the estimate including the steel and all other items of construction except mere excavation, which was not included in the first estimate. The concrete wall would therefore cost $10.16 per linear foot, which is practically one-half of that of the stone wall. Many other illustrations could be given where reinforced concrete construction is the cheapest that gives a permanent structure.

As an instance of the second class of structures, viz.: those in which reinforced concrete is almost the only practicable method of construction, the following case is given. It was required to construct a retaining wall with a height of 36 feet above the rails of a sunken track where the right-of-way was absolutely limited to a width that gave 10 feet from the right-of-way line to the clearance line for the tracks. The wall was designed to have its base 42 feet below the top. Of course, 10 feet is too small a base for a 42-foot retaining wall. The only possible solution appeared to be some provision by which the toe of the wall could extend underneath the track. Of course, such a construction in stone masonry, or even in plain concrete, would be an utter impossibility, since it would inevitably break at the angle at the base. A structure of concrete and steel in which the transverse stress at the lower angle of the wall is resisted by the horizontal steel bars in the base, with the very considerable pressure of the earth on the base-plate behind the face-wall, accomplished all that it desired. The resultant line of pressure is within the middle third of the base, while the maximum intensity of pressure on the subsoil was computed to be about 6,400 pounds per square foot. As the subsoil is a very firm gravel, this pressure is a perfectly safe one, but if it had been found that the soil was less reliable it would have been a comparatively simple matter to enlarge the foundation as much as necessary. Of course, the conditions of this problem were very peculiar and unusual, and it illustrates what can be done under such circumstances.

The third class of structures, viz.: those in which reinforced concrete is simply preferable, may be illustrated by the very simple case of fireproof floors. One of the compensations of the Baltimore fire was its demonstration of the fact that a concrete floor, when properly made, approaches the ideal by being more nearly absolutely fireproof than any other flooring material. It has been frequently stated that since concrete is formed by the crystallization of a compound containing water, it only requires heat to drive off the water and render the whole structure worthless from a structural standpoint; but the Baltimore fire proved that even with the very excessive degree of heat which was developed during that fire, the effect of such heat on a concrete floor was merely to calcine the lower layer of concrete to a depth varying from a half inch to an inch. After such calcination occurred this layer of heat-resisting material proved to be such a thorough protection that the concrete above it was uninjured, and considering that the concrete that lies above the axis of the reinforcement is the only portion which is considered in calculating its strength, and also considering that an inch or two of concrete is always placed below the steel reinforcement, even the destruction of an inch of concrete on the lower side of a concrete slab will not impair its structural strength. After such a fire, the injured material may be scraped off, so far as it is loose, and another protecting layer, which is only put on for protection and not for structural strength, can be added.

Another very satisfactory use of reinforced concrete is in the construction of roof-slabs for fireproof buildings. The author has recently constructed a factory and boiler house entirely of concrete. Even the side walls were built of hollow concrete blocks. The floors are of concrete, the roof-slab of concrete, and even the stairs are made of concrete. The boiler house has a roof with a clear span of 30 feet formed by placing a 4-inch slab on concrete beams stretching across the span of 30 feet. The beams have a depth of 13 1-2 inches under the slab and a width of 7 3-8 inches. They are spaced 6 feet 2 1-2 inches apart. The slab is reinforced by 1-2 inch bars spaced 16 inches apart. Only a few weeks after the roof was in place and before the concrete had attained anything like its full strength a very unexpected and unintentional test of the roof occurred. A steel stack was being erected, the stack being put in place by means of a derrick. The derrick broke, a large gin-pole was broken in three pieces, the stack crumbled up, and the whole mass of wreckage fell on this roof. No injury whatever was done to the roof.

The term "formed" bar is here used as a generic term to denote any style of bar which is not prismatic. A prismatic bar depends on adhesion or friction for the union of the concrete and the steel. A "formed" bar has shoulders, lugs, twists, swellings, or irregularities which not only more or less effectively prevent the loosening of the adhesion by varying the planes of adhesion and thus varying the

direction of the forces which will most probably loosen the adhesion, but they even call into play the shearing strength of the concrete before the rod can be pulled through it, even if the adhesion be destroyed.

Much experimenting has been done to determine the adhesion of concrete to steel. It has been found that when the steel is clean concrete will adhere to it with an adhesion which is equal to the strength of the bar when the length is approximately 12 to 20 diameters. Unfortunately the adhesion, as determined by such tests made shortly after the specimens were formed, has been shown to lack permanency. This may be due to one of three causes. First, the adhesion may be loosened by vibration in the structure—such a vibration as will occur in a railroad bridge or in a factory employing very heavy machinery. Second, some cases in which the concrete was found to have loosened were explained on the ground that water which had soaked through the concrete had made some chemical change in the concrete immediately adjoining the steel which was sufficient to loosen the adhesion. Third, it is reasonable to say that when the structure is stressed to its full load (and especially if it should accidentally be stressed beyond its designed load) the stretching of the bar must be accompanied by a proportionate reduction in its cross-section. Evidently the concrete will be unable to contract so as to retain its contact with the steel, and therefore the steel must separate from the concrete. Probably the number of applications of a given load will have a marked effect on this, and it would be found, after applying a load a very great number of times (say 1,000,000), that loosening might take place even though no evidence of such loosening would occur by the application of the same load a few times. An instance of this sort occurred in a building erected in St. Louis about 10 years ago. A 6-inch concrete slab carrying a heavy floor-load was supported by steel I-beams spaced about 8 feet apart. The concrete was reinforced by 1 1-4 inch by 1-4 inch bars or straps which were hooked over the I-beams and dropped down on a curve toward the bottom of the concrete slab in the middle of the span. The floor safely carried a heavy floor load for about eight years. Then several panels began to yield. The floor sagged one and a half inches in the middle, which on an 8-foot span gave a very unsightly and unsafe appearance to the floor. One or two panels caused so much anxiety that they were knocked out entirely. It was at once observed that the concrete peeled off the bars, and it was plainly evident that the adhesion between the bars and the concrete had been destroyed, the load then being carried by the hog-chain action of the straps. It should be noted in this case that for about eight years the floor did its work and carried a very heavy load, thus proving that the ultimate failure was not due merely to poor workmanship, but was due to the fact that the adhesion of the bars was not permanent. This fact has been recognized by the city of Philadelphia in recent specifications for reinforced concrete bridges, in which it is required that the "steel rods embedded in the concrete shall be of some approved shape, especially formed for reinforcing concrete so as to secure an interlocking bond between the steel and the concrete."

It has, however, been very definitely demonstrated that a mechanical bond furnishes a far stronger union between the steel and the concrete than can possibly be furnished by plain bars. About two years ago Professor Spofford made a series of tests in the laboratories of the Massachusetts Institute of Technology to determine this very point. A large number of specimens, of which 45 were reported in the published tests, were made by molding prisms of concrete. The prisms varied in cross-section from six inches by six inches to ten inches by ten inches, and in length from twelve inches to fifty inches. The rods included plain round, plain square and plain straps, also Ransome, Thacher and Johnson bars of sizes varying from a half inch to one and a quarter inches and with a length somewhat greater than the length of the prisms. They were placed in the axes of the prisms during molding. The load upon the bearing end of the concrete block was distributed by the interposition of a sheet of half-inch felt between the concrete and an annular steel ring resting upon the platform of the machine. In all cases the rod projected a short distance at the upper end of the block, the pull being downward at the lower end, and this projecting end was carefully watched in order to detect the first evidence of slipping. Although it was intended that the size of the prism should be sufficient in all cases to develop the full strength of the bar, it was found that the largest bars were too large even for the 10-inch by 10-inch prisms in which they were inserted. It was invariably found that the formed bars required a far greater stress in the rod in pounds per square inch of net section than the plain bars. Incidentally it may be mentioned that the Johnson corrugated bar invariably required a pull from two to three

times as great per square inch of net section as a plain bar. These results therefore show—first, that if the stress in a reinforced concrete structure for any reason exceeds very greatly the designed loading and approaches the elastic limit of the steel, a formed bar is far safer than a plain bar, even though the adhesion has not been destroyed. Secondly, experience has proved that the adhesion may be destroyed by any one of three causes, and that it is unreliable for any great length of time, no matter what its tested strength may prove to be on new specimens. Thirdly, that a Johnson corrugated bar will have as great a hold in the concrete as a plain bar at its best, even though the adhesion of the Johnson bar had been utterly destroyed by vibration or any other cause. Incidentally it may be added that the writer has been told of some tests which were made on this line in which the bars were deliberately oiled in order to determine their hold in the concrete under such a condition. It was found that there was practically no adhesion and that the bars could be drawn out of the concrete with an insignificant force. This practically means that if the reinforcing steel should be accidentally smeared with oil or grease the adhesion would be vitiated to some extent, and since the mutual action of the concrete and the steel is absolutely dependent on the intimate union of the concrete and steel at all points, the strength of the structure might be vitiated to perhaps a dangerous extent by some carelessness during construction. In the tests made at the Massachusetts Institute of Technology all the bars were sand-blasted, which, of course, made the conditions the most favorable for the plain bars. Of course, it likewise made it most favorable for all kinds of bars. But oil on a formed bar would merely reduce its adhesion and not destroy the union between the concrete and the steel. On the other hand, oil on a plain bar will render it utterly useless and endanger the strength of the structure. It is also true that if the bars have been allowed to get rusty to any great extent the adhesion is affected.

There is still much controversy over the effect of the elastic limit on the mechanics of reinforced concrete structures. The writer has no intention of entering into a theoretical argument on this point, but will merely point out the fact that there are some phases of this detail which are beyond discussion. It may readily be seen that when the steel is strained beyond its elastic limit the union between the concrete and the steel is unquestionably destroyed. If that union depends on mere adhesion, it is certainly destroyed absolutely. If the bars are specially formed, there will still remain a very great resistance, although the structure is unquestionably very seriously weakened, if not actually unsafe. Therefore, if we can safely raise the elastic limit, we raise by just that amount the safety of the structure. A great deal of work has been designed using steel which has an ultimate strength of, say, 64,000 pounds per square inch, and using a working stress of 16,000 pounds, and the designer thinks he has a factor of safety of 4. If the ultimate strength is 64,000 pounds, the elastic limit is probably about one-half of this, or 32,000 pounds. Therefore the real factor of safety is only 2. In other words, if the loading should ever by any mischance be increased to more than double the normal loading, the structure would actually fail, since the elastic limit would have been passed, and, as above shown, the elastic union between the concrete and steel would have been destroyed.

There is a radical distinction between a steel concrete structure and an all-steel bridge, for example. If a steel bridge be overloaded to such an extent that the unit stress is raised to a little beyond the elastic limit, the structure will not necessarily fail. When the stress is removed, the bridge will not entirely recover its former position, the cross-section of some tension pieces will be slightly reduced, but the unit strength is possibly greater, and the bridge can still do its normal work, although the factor of safety may have been slightly reduced. But when the steel in a steel-concrete structure has been stretched beyond the elastic limit, the steel and concrete can not return to the same relative positions they previously had. The union is unquestionably destroyed. Under such a condition the formed bar is certainly safer than a plain bar, but a combination of formed bar and a high elastic limit is far better. Several years ago bridge engineers thought they could effect economy by employing high carbon steel in the construction of bridges. Then they found that, owing largely to punching and the irregular stresses produced in plates and structural shapes, the high carbon steel was unreliable, and now a return has been made to the softer steel. But when it is considered that there is no question of punching the steel used for steel reinforcement, and that the stresses in the steel are almost exclusively tensile, the ability of the high carbon steel to safely withstand them can not be successfully attacked, provided the steel is not actually brittle. The shearing stresses which may occur in the steel bars are

always so far within the shearing strength of the steel that they need not be considered. The Johnson corrugated bars are usually rolled from the same grade of steel as is employed in making railroad rails. There are few metal structures which are subjected to such excessive and irregular stresses as railroad rails. From the standpoint of impact and change of stress there are few metal structures which are so tried. Nevertheless a broken rail is exceedingly rare, considering the hundreds of thousands of miles which are in use. Therefore it would seem like an over refinement and a needless sacrifice of strength to limit one's self to a grade of steel which has a virtual limit of 30,000 or 32,000 pounds per square inch when it is so easily possible to obtain a material which is thoroughly reliable for its purpose, against which no failure can be reported, and which has a virtual ultimade (by which I mean the elastic limit) of 55,000 to 65,000 pounds per square inch. Such a bar can be as safely used with twice the working strain as would be used with soft steel, or, if it is used with the same working strain, the factor of safety against a possible overloading is practically doubled. Of course, I would not advocate for a moment using a working stress of 25,000 to 30,000 pounds per square inch with the higher grade steel. In fact, Mr. Johnson usually employs 12,500 pounds per square inch working stress with his bars, in spite of the elastic limit of 55,000 to 65,000 pounds and an ultimate strength of 95,000 pounds. But I do wish to express very strongly the opinion that using a working stress of 16,000 pounds for soft steel in steel-concrete work is not only bad designing—it is recklessness.

It will not do to say that overloads will never occur. A cyclone may produce wind stresses in a building which are several times the stresses provided for, and it is a common experience to see a warehouse floor loaded up with a floor load which is four or five times that for which it was designed.

It is natural that some engineers should have considerable sceptism regarding the accuracy of theoretical computations of the strength of reinforced-concrete structures. The theory is excessively complex, and, secondly, concrete is by some considered a very unreliable material. There is therefore considerable value in the tests which were made recently by Professor Howe at the Rose Polytechnic Institute, Terre Haute, Ind. These were tests of full-size concrete beams which were purposely made so as to represent commercial practice as closely as possible. Atlas cement, bank sand, crushed rock and corrugated steel bars were purchased in the open market. The mixing was done by a local contractor of experience with his own gang of men in the manner he ordinarily employed. Instead of using "standard quartz sand," which is so frequently used in test work and which gives results which can not be compared with commercial practice, he used a sand which, "while containing some 'dirt' in the form of yellow clay, was a fair representation of bank sand used in Terre Haute." The beams varied in length from 12 feet to 19 feet 6 inches. They had a uniform width of 12 inches, but their depth varied from 5 inches to 21 inches. It is difficult to apply a uniformly distributed load to a full-size beam and avoid a tendency to arching action of the load itself, which vitiates the results obtained. A concentrated load in the center also tends to produce a crushing of the beam, which may vitiate the calculations of its transverse strength. The method employed in these tests was to apply two equal concentrated loads, which are symmetrical with respect to the center of the beam, through knife-edges in rolling seats, which thereby produced a constant bending moment between the points of application of the load (excepting the variable moment produced by the weight of the beam). Usually the maximum moment actually developed was somewhat in excess of the theoretical moment as determined by the Johnson formula, probably on account of the fact that the Johnson formula uses 2,000 pounds per square inch as the ultimate strength of that grade of concrete, and 50,000 pounds per square inch as the elastic limit of the steel (which is in reality the point of failure in steel-concrete work), whereas the strength of the concrete was probably somewhat in excess of this, and the steel used actually showed an elastic limit of about 60,000 pounds per square inch. The vertical deflections were read directly from a scale on the side of the beam at the center by means of a silk thread fastened opposite the knife-edges of the end stirrup. Measurements were made to determine the position of the neutral axis for various loadings and the variation of its position for partial loadings. It was very definitely shown that at the commencement of the loading the neutral axis was below the center of the beam. Theory would indicate that for a light loading the neutral axis would be at the center of gravity of an inverted T-shaped section, the sides of the T being formed by extending the concrete at the base of the beam by an amount proportional to the

relative moduli of elasticity of steel and concrete, but it is found that, as the loads increase in magnitude, the axis moves upward very rapidly until cracks commence to appear on the bottom of the beam; then the axis remains approximately in the same position as long as the concrete does not show signs of failure in compression, as indicated by the drop of the scale beam. The special point to which I wish to call your attention in these tests is that in all the eighteen tests there were but six cases in which the actual maximum moment was less than the theoretical moment. Ordinarily the variation did not exceed 3 per cent. Such an agreement between theoretical formulas and the actual breaking loads of full-sized commercially made beams is not only very gratifying, but is sufficiently close to inspire confidence in the method of the calculations. The method of calculating the strength of simple beams reinforced with steel is practically much simplified by the use of tables and diagrams.

Another very important feature of this method of construction is the solution which it gives to the problem of expansion joints. altogether. This may be safely done on the same general principle as is involved in the rpactice of street railway companies in usmg perfectly tight rail joints. In the case of the rails the changes of temperature do take place, and they result in severe tensile stress in cold weather and compressive stress in warm weather, but it is easily demonstrable that for such ranges of temperature as will occur the stresses are not unsafe and that the rails can safely endure them. Precisely the same principle is involved in reinforced-concrete walls. It is demonstrable that if 1-300 of the cross-section of the wall consists of steel properly distributed, all tendency to contract during cold weather will be resisted by the steel, and it is thus made possible to make concrete structures a mile long, if desired, without using any expansion joints. Experience in these structures has demonstrated that masses of concrete so long that they would inevitably have been badly ruptured by temperature contraction if they had been made of plain concrete, have successfully withstood all ranges of temperature without any cracking. In fact, the insertion of steel in structures merely for the purpose of withstanding this temperature cracking is not only justifiable, but a wise plan, even though the steel was not depended on to resist any other structural stress. This may explain an element of the design of some of these structures where bars are inserted in places where they are apparently unnecessary for withstanding structural stress. They are inserted as binders to prevent any possibility of the concrete cracking on account of temperature stresses.

In order to have some more definite figures regarding this, I wrote to the engineer of the St. Louis Expanded Metal Fireproofing Co. for some explicit examples. An extract from his letter is as follows:

"The rear wall of the Harvard stadium is 1,400 feet long, built in the form of a U, and the same contains but one crack at one of the points of tangency, which may have been due to some improper workmanship at this point, perhaps. This job was passed through two severe winters, and my report on the condition of same comes direct from Prof. L. J. Johnson, the man who had the work in charge.

"There is a retaining wall illustrated in our new catalogue which has passed through one winter and contains no crack. We built a wall in the city here, exposed on both sides to the weather, which is also 300 feet long and contains no crack. It is not that the metal absolutely prevents cracks, but if the metal does not slip in the concrete, the cracks will be very fine and close together, and these will be so small that in the case of the corrugated bar, at any rate, they would not be able to penetrate to the bar."

This is another illustration of the value of a "formed" bar over a plain bar. It is quite possible that temperature changes are one of the most potent causes of the loosening of the adhesion. Corrugations, and especially those which present a square shoulder against any tendency of the bar to move in the concrete, make such an intimate union between the concrete and the steel that temperature changes can not affect them provided the cross-section of the steel is sufficient to resist the temperature stresses.

Unprotected steel rusts quite rapidly, especially when it is exposed in damp places, and since concrete is more or less porous, so that water may penetrate throughout a concrete structure, it is frequently assumed that even the embedded steel will rust out. Although it is true that the modern system of reinforced concrete is a matter of the last few years, and therefore there has not been time to determine many of the results which will only appear after many years, there have fortunately been many occasions when the power of concrete to protect iron from rusting has been amply demonstrated. Wm. Sooy-Smith, M. Am. Soc. C. E., reports a small piece of iron set in mortar taken from the base of the obelisk

now in New York city which was bright and free from rust after 2,300 years. He also tells of the moving of a bed of concrete at a lighthouse in the Straits of Mackinac, twenty years after it was laid 10 feet below the water surface. In this case drift-bolts embedded in the concrete were found to be free from rust. Many tests have been made in which it has been attempted to substitute for long periods of time a corresponding intensity of corrosive action, and although the results of such tests are not conclusive proof, yet they all point to the same conclusion, viz.: that if concrete is mixed very wet so as to make it very dense, and if the steel is covered to a depth of an inch or more, there is absolutely no evidence of rusting, unless the steel is exceptionally foul when it is placed in the concrete. There has been considerable controversy over the possible effect of the fine hair line cracks which frequently appear in the bottom of a concrete beam even when it is loaded within its designed loading, but the eminent chemist and cement expert, Spencer B. Newberry, has declared unequivocally that there is no danger that such cracks would result in corrosion of the steel under them. He points out the fact that the immediate effect, even when such a crack began to open, would be a slight chemical change and the formation of a carbonate at the bottom of the crack, which would effectively protect the steel from any corrosion.

Sand for Mortar and Concrete.*

BY SANFORD E. THOMPSON, C. E., BOSTON, MASS.

The variation in the strength of mortars with different kinds of sand is recognized in the adoption of a standard sand for cement testing. Notwithstanding this long-time recognition of the necessity for uniform sand in order to produce uniform results, too often in practice, while cement must attain a definite tensile strength or be rejected, "sand is sand." Doubtless you, to whom I am speaking, are only too well acquainted with this disregard of the effect of sand upon the strength or setting qualities of a mortar, and have been called upon not infrequently to take back cement which was pronounced "no good" when, in reality, the sand, and not the cement, was at fault. As Portland cement manufacturers, you yourselves are in a measure to blame for the comparative indifference to this matter of selection of sand, because your product has attained so high a quality that a really good mortar or concrete can be made with it, even though the aggregate may be very inferior; and, furthermore, the price of cement is now such that it is often more economical to increase the percentage of cement than to carefully select or grade the aggregate.

As is frequently the case, if but one kind of sand is available for a job, the question is simply whether this shall be employed with a sufficiently rich mixture to give the required strength or whether sand shall be transported from a distance at an excessive expense. On the other hand, if two sands are available, an intelligent selection may admit of a material decrease in the percentage of cement without detriment to the resulting mortar or concrete. Many a time, for example, a 1:3 mortar can be made equal or even better in quality than 1:2 mortar made with poor sand, with a consequent saving, we may estimate, of three-quarters of a barrel of cement per cubic yard of mortar. Similarly, in concrete, the substitution of proportions of 1:3:6 for 1:2:4 may reduce the quantity of cement nearly one-half barrel per cubic yard of concrete. On a large contract, in such cases, it certainly pays, from the standpoint of the contractor, to incur the expense of transportation of good sand, or else to spend considerable labor on the preparation of the sand nearest at hand. And, indeed, in the final analysis, it pays the cement manufacturer also, because every increment of saving in the cost of mortar or concrete serves to promote the use of concrete as a structural material.

To illustrate the variation in strength, in density, and also in permeability of mortars and concretes made with sands of different qualities, I shall present a series of tests recently made in my own laboratory, adding a few suggestions in regard to practical principles governing the selection of sand and the proportioning of mortar and concrete. First, however, I wish to refer briefly to the causes of variation in strength and to the methods of examining and testing sand.

The primary cause of the difference in strength of mortars having the same proportions of cement but composed of different sands, lies in the size of the sand; that is, the coarseness and relative coarseness of the grains. There are two principal elements in the strength of mortars, namely, percentage of cement and density, and with the same proportion of cement, the sand producing the densest mortar, that is, the mortar with the smallest percentage of voids, is the strongest.

The voids in mortar are governed by the size of the grains of the sand, in combination with the cement and the

*From a paper before the Association of American Portland Cement Manufacturers.

water—all three elements must be considered. If the grains of sand are large, the water will have little effect upon the nature of the sand and the cement will serve to fill the voids, making the resulting mortar as dense or rich as the required proportion of cement allows. If the grains of the sand are fine their voids are too small for the cement grains to enter, and the addition of cement forces the sand grains apart instead of simply filling the voids. Besides this, more water will be required in the mixing, and this water will surround and coat the fine particles, still further increasing the bulk and consequently the voids.

On the other hand, if the finer sand grains, taken with the cement and water, are insufficient to fill the voids, the mortar or concrete will be coarse or harsh.

It is thus evident that the sizes of the sand particles should vary with the proportions of cement to sand to the mortar or concrete, a lean mortar requiring more very fine sand than a rich one to assist the cement in filling the voids and thus increasing the density.

While the shape of the grains of sand also has certain influence upon the density, it is usually so slight as to be negligible.

Cleanliness of sand is usually a function of the size, because in most cases the dirt is generally nothing but fine mineral matter, but apparently the impurities may sometimes be of such nature as to affect the cement chemically. I have known several cases where the failure of concrete to set up for a very long period has been traced directly to the quality of the sand, but I have never yet heard an entirely satisfactory explanation of the causes of this retarding influence. It would sometimes appear that the trouble is due to mechanical rather than to chemical causes, the particles of loam or clay in the sand being so extremely fine that the water of the mixture is retained hygroscopically, and thus retards the setting.

In the selection of sand the most common tests are those for weight and voids, but for two reasons these produce misleading results. First, the tests with dry materials, as I have already indicated, will not necessarily correspond to and predicate the effect of the same materials when mixed into a mortar. Second, the difficulty of obtaining uniform conditions with different sands prevents accurate results. For example, a very fine sand, with grains of uniform size, when dry, will have very nearly the same percentage of voids as a coarse sand with grains of uniform size, but with moisture as found in the natural bank the conditions are very different, the fine sand being lighter in weight and having a much larger percentage of voids than the coarse, and, furthermore, the weight and voids vary with the percentage of moisture. Yet, as a general rule, we may say that the heaviest sand and the one with the fewest voids is the best, but this is by no means an entirely reliable guide. It is a simple matter to determine the percentage of voids in a sand. The specific gravity of most sand ranges from 2.64 to 2.70, and by first determining the moisture and correcting for this, the voids may be calculated from the weight of a unit volume. But what shall be the condition of the sand when testing the voids? Shall it be dry or moist, loose or shaken, measured in a small measure or in a large one? Every one of these variations will give a different percentage of voids, and if we make use of the void determination to fix the proportions of cement to sand, the same sand may be readily shown to require either 1 :2 or 1 :3 proportions, or any ratio between the two, according to the condition of the sand and the method of handling it.

If then, we discard the void test of sand because of its unreliability, what means shall we use for comparing the quality of different sands?

There are three methods of testing sand which will give satisfactory results under proper conditions:

(1) Actual tests of strength of different mortars or concretes made with the sands under consideration;

(2) Determination of percentages of the different sized grains by sieve separation;

(3) Volumetric tests of the mortars or concretes made with the different sands, for determination of yield and density.

Tests of strength require time for the specimens to harden, and are subject to the variations incidental to mixing and molding.

It is probable that a direct examination of the sizes of the sand and other aggregate by screening a sample and then plotting curves of percentages passing will eventually prove to be the correct method to follow. However, as yet our records are too few and our knowledge of the laws of mixtures and the effect of water upon the different sized grains too limited to depend upon this alone to give positive indications of comparative values of different sands.

The volumetric or density test, which consists in determining the volume or yield of any mortar, I consider one of the best methods of testing sand. Different sands can be compared using the same proportion of cement, and the density with different proportions of cement to sand may be studied, while, in fact, even the approximate comparative strength of the

different mortars may be closely estimated.

This test, as made in my laboratory, is a modification of that employed by Mr. R. Feret, the eminent French authority, and the apparatus is similar to that adopted in recent tests for the New York Aqueduct Commission at Jerome Park Reservoir. The cement and sand are weighed and mixed in the required proportions, and sufficient water added to make a mortar of about the consistency used by a stone mason. This is introduced into a 250 cubic centimeter graduate, little by little, slightly compacted, and, after setting for about an hour, the surplus water is poured off, and the volume is read on the scale. In general, if two sands are to be compared for use in any given proportions, the sand which produces a mixture of smallest volume will also produce a mortar of greatest strength. If the two sands vary appreciably in specific gravity, this must be corrected for when weighing them, so that the sum of the volumes of the sand particles will be the same in each case. The appearance of the mortar in mixing and placing also provides indications of the quality of the sand. It should work smooth and be reasonably free from air bubbles, with only a slight excess of fine material on the surface of the mortar in the graduate. For complete study of the sand, it is necessary also to calculate the density of the mortar and the absolute volumes of the cement and sand.

The density test is applicable either to natural or to artificial sands. Just how far it may be used for comparing the value of a natural sand with that of an artificial sand, like broken stone screenings, has not yet been thoroughly investigated.

The series of tests to which I have already referred shows the effect of the fineness of sand upon the strength of mortar and illustrates the practical use of the tests for density. A few tests of the permeability of concrete were also made with the cement and sand in the same proportions as in the volumetric and strength tests.

Natural sands were selected so as to make the results as practicable as possible, although there would have been even greater variation if the sands had been prepared by artificial screening. The three sands were taken from the same bank, and may be designated for convenience as No. 1, No. 2 and No. 3.

No. 1, coarse sand, was the run of the bank, including all material finer than ¼-inch diameter:

No. 2, fine sand, was taken from a layer in the same bank:

No. 3, very fine sand, was taken from another layer in the bank.

	Per cents. passing.		
Size of Sieve.	No. 1 Sand.	No. 2 Sand.	No. 3 Sand.
¼-inch	100	...	...
No. 5	88	...	...
No. 12	77	100	100
No. 40	32	84	96
No. 200	3	6	27

The sieves which I have used in this table, No. 5, No. 12, No. 40 and No. 200—the numbers corresponding in each case to the meshes per linear inch—correspond closely to those adopted by Mr. Feret in France for separating sand, with the exception of No. 200, which is required for determining the amount of dust, and in most cases these are sufficient to give an excellent idea of the composition of a sand. With these screens the maximum size of sand grains as distinguished from gravel are those which just pass a No. 5 sieve and measure slightly over ⅛-inch diameter.

The gage of the wire in the wire cloth appreciable affects the size of the opening and consequently the size of the sand grains passing. The wire cloth which I employ, sometimes called market size, is as follows:

Commercial No. sieve.	Meshes per linear in.	Gage of wire.	Width of opening in.
5	5	19	.1600
12	12	24	.0583
40	40	33	.0148
200	200	...	.0030

As is usually the case, the fine sands retained the largest percentages of moisture, the coarse sand as it came from the bank having 4.2 per cent. moisture by weight, the fine sand 5.6 per cent. and the very fine sand 7.3 per cent. moisture.

I have referred to the variations incident to void tests of sand. I cannot better illustrate this than by showing the results of void tests made upon the three sands employed in these experiments.

Weight and Voids in Moist and Dry Sand Under Different Conditions of Compacting.

	Coarse Sand. No. 1.	Fine Sand. No. 2.	Very Fine Sand. No. 3.
Weight per cubic foot with moisture—			
Moist and loose...	79	67	65
Moist and shaken.	97	84	82
Weight per cubic foot, dry—			
Dry and loose....	100	92	90
Dry and shaken...	104	98	97
Percentages of Voids in Moist Sand.			
Air Voids—	No. 1.	No. 2.	No. 3.
Moist and loose...	50	56	57
Total voids, air and moisture—			
Moist and loose...	53	62	63
Air voids—			
Moist and shaken.	38	45	46
Total voids, air and moisture—			
Moist and shaken.	42	52	53
Percentages of Voids in Dry Sand.			
Dry and loose....	39	44	45
Dry and shaken..	37	41	41

Notice the extreme variation in the percentages of voids in the same sand. Thus, the coarse sand, No. 1, ranges from 53 per cent. total voids if measured loose and moist, to 37 per cent. measured dry and shaken. The finest sand ranges under similar conditions from 63 per cent. to 41 per cent. There is, as you see, a very much greater variation in the same sand, due to moisture and different methods of compacting than between two different sands under the same conditions. For example, in the laboratory the sand is generally handled dry, and the voids in the coarse sand, No. 1, when measured dry and shaken, are 37 per cent., while the voids in No. 3, the finest sand, are 41 per cent., a difference of only 4. If measured loose the difference is but 6. Yet the coarse sand, No. 1, produced a mortar which at the age of seven days was more than double the strength of the mortar with fine sand mixed with cement in the same proportions. Or, taken in another way, in order to attain the strength of a 1 :3 mortar made with the coarse sand, it would be necessary to mix the cement with the fine sand in proportions of 1 :1¾. Can we place much reliance on void tests of sand when different conditions will produce such wide variations in weight and voids?

The densities of the three mortars were found to be 0.689 for the mortar of coarse, No. 1, sand; 0.620 for the fine, No. 2, sand, and 0.600 for the very fine, No. 3, sand. That is, the total air plus water in the three mixtures was 31 per cent. for the coarse sand, 38 per cent. for the fine sand, and 40 per cent. for the very find sand. These percentages represent the actual porosity of the mortars when fresh. The chemical combination of the cement and a small portion of the water reduces the porosity slightly with age, but for density tests the fresh mortar alone is considered. The mortar of coarse sand with its 0.689 density, or 31 per cent. air plus water voids, represents a good average mortar.

Two-inch cubes were next made with mortar in the same proportions, using the three sizes of sand, and these were broken at the age of seven days. The resulting strengths averaged 714 pounds per square inch for the mortar with coarse sand, 405 pounds per square inch for the mortar of fine sand, and 330 pounds per square inch for the mortar of very fine sand, thus showing the coarse sand to give more than double the strength of the fine when mixed with cement in the same given proportions.

COARSE vs. FINE SAND FOR MORTAR.

Compressive strength and elementary volumetric composition of 2-inch cubes of Portland cement and bank sand.

Sand.	Proportions by Weight.	Proportions. by volume (nominal).	Elementary Volumes.		Density	$\left(\frac{c}{1-s}\right)^2$	Actual Average Compressive Strength Age 7 days.	Estimated Compressive Strength at 6 months K=28,000
			Cement.	Sand.				
			c	s	c+s		lb. per sq. in.	lb. per sq. in.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
No. 1 Coarse.....	1:2.64	1:3	.171	.518	.689	.126	715	3530
No. 2 fine..	1:2.64	1:3	.154	.466	.620	.083	405	2320
No. 3 Very fine..	1:2.64	1:3	.149	.451	.600	.074	330	2070

Note.—Quantity in column 7 is from Feret's formula,

$$P = K\left(\frac{c}{1-s}\right)^2$$

in which K is a constant varying with the age of the specimen and the quality of the cement. Relative strengths of similar mortars are in direct proportion to this quantity, and by means of it the compressive strength in column 9 is calculated, assuming an average value for K of 28000.*

*For further discussion see Taylor & Thompson's "Concrete, Plain and Reinforced," pp. 134 to 151.

The cubes were made too recently to permit long time tests, but by means of the density tests it is possible not only to compare different sands, but by calculation to closely approximate the actual strength of the mortars. Thus the compressive strength at the age of 6 months, as estimated by Feret's formula, should be approximately 3530 pounds per square inch for the mortar of coarse sand, 2320 for the mortar of fine sand, and 2070 pounds per square inch for the mortar of very fine sand.

The method of making the 2-inch cubes may be of interest, as I do not know of it having been used before for test specimens, although it is in commercial operation for casting artificial stone. I employed the process of sand molding. Wood patterns were first made the size of the cubes required, and molds were formed in fine molding sand as for iron castings. The mortar was mixed to wet consistency in a small laboratory mixer, and poured into the molds, the sand absorbing the surplus water. After remaining in the moist sand for 24 hours, the cubes were removed and placed in water until tested. One of the objects of this method of procedure was to eliminate the variations occasioned by different percentages of water and different degrees of compacting in the ordinary method of brass molds. I have not made sufficient tests to even suggest this process for general use in testing cement, although I have employed it for making large mortar blocks for compression tests with extremely satisfactory and uniform results.

Until recently I have been of the opinion that the density of a mortar was also an exact indication of its water-tightness. Recent tests, however, have led me to question the direct relation between the two qualities. The permeability tests in the present series are not yet far enough advanced to draw positive conclusions, but they indicate a marked difference between the laws of strength and permeability. Concrete specimens were mixed in proportions of 1:3:6 by volume, based on 100 pounds of cement per cubic foot, and using gravel for the coarse aggregate. For the fine aggregate, No. 1 coarse sand and No. 3 very fine sand, and mixtures of these two were used in different specimens. The results showed the concrete with coarse sand to pass considerably more water at the age of 14 days than the concrete made with very fine sand, although the strength of the mortar of coarse sand was more than double that of the fine sand mortar. The flow through the specimens with mixed sands was not very different from the flow through the one with all fine sand.

The results indicated by the tests are that a certain percentage of fine sand is absolutely essential for water-tightness in a mixture as lean as 1:3:6, and after this percentage is reached (in the case of our tests one-sixth of the coarse sand was replaced by the very fine No. 3 sand), there is not very much change in the flow through the specimen by the further increase in quantity of fine sand, or even by the entire substitution of fine sand for the coarse. With proportions 1:2:4 there appears to be such an excess of cement that no additional fine sand is needed. Comparative tests of two specimens of a series made for Mr. Bertram Brewer, city engineer of the city of Waltham, Mass., which city is contemplating the construction of a concrete standpipe, showed scarcely any difference between a bank sand of the nature of No. 1 and the same sand mixed with one-third of very fine material.

A point of interest which may be noted in connection with these and other similar tests is the fact that the fine sands require a larger percentage of water than coarse sands to produce the same consistency of mortar, the required percentage varying, in fact, with the fineness of the sand. Thus in the density tests, to obtain a soft mortar of uniform consistency in each case, it was necessary to use 15 per cent. of water to the weight of cement plus the coarse sand, 21 per cent. for the cement and fine sand, and 24 per cent. for the cement and very fine sand. In the permeability blocks, 7 per cent. of water to the total weight of dry material was used in the specimen with coarse sand, this corresponding to 20 per cent. of the weight of the cement plus sand, which is a better way of expressing the quantity of water in concrete, while the concrete with the very fine sand required 8 per cent. of water to weight of total dry materials, or 24 per cent. to weight of cement plus sand to attain the same consistency as the other. The concretes with mixed sands required percentages of water intermediate between these two.

The results thus far have dealt only with natural sand and mixtures of natural sands. Our knowledge of the effect of fine and coarse sand is now beginning to be applied to artificially screening sand into two or three sizes and then mixing them in proportions determined by theory and experiment. Bank sand, or artificial sand containing moisture, must be dried before separating the fine sand particles, but even this expense is not prohibitive in a factory manufacturing concrete blocks or even upon a large structural job, when, as a consequence, the

proportions of the concrete may be made leaner and a large saving effected in the proportion of the cement.

For concrete under water pressure I have found by experiment a small percentage of hydrated lime or of slaked lime putty to appreciably increase the water tightness. Puzzolan cement also has been mixed with Portland cement and used in marine construction to produce a lean impermeable mortar. Several patented compounds are now upon the market, some of which may eventually prove valuable for increasing water tightness.

The question frequently is asked as to the best composition of sand for concrete. As already indicated, there can be framed no general requirements suited to all conditions. In the case of a small job it is usually unnecessary to restrict the contractor to definite size, because it will be cheaper to use rich proportions than to incur the expense of careful grading.

For mortar sand, Mr. Feret's rule that the coarse grains should be double the fine grains, including the cement, forms a guide to the best grading. For the strongest mortar, such a rule would require for 1:2 proportions no sand grains passing No. 40 sieve; for 1:3 mortar, 11 per cent. of the sand grains passing this sieve, and for 1:4 mortar, 17 per cent. Sand for concrete, I find requires more fine material than mortar sand, and tests indicate that the best percentages passing a No. 40 sieve may range from about 18 per cent. for a 1:2:4 concrete up to 27 per cent. for a 1:4:8 concrete. For water-tight concrete even a larger percentage of fine grains appears to be beneficial. As regards dust, that is, the mineral matter passing a No. 200 sieve, good results are attained in rich mortar and concrete with no sand grains finer than this, while for lean mixtures, say, those in which the proportions of cement to sand are 1:4, as high as 10 per cent. may be beneficial, and a larger per cent. may be used without detriment. While it is impracticable to limit fineness in practice to the exact percentages suggested, they will serve as a guide for comparison and selection.

I cannot well close this paper without touching more definitely upon the general requirements in proportioning sand for concrete. I have already referred to the sizes of sand which from tests thus far made appear to produce the best results. Much finer sands can be used with safety, in fact, if a good coarse sand is not available, almost any size of sand may be used if sufficient proportion of cement is added, provided it is positively proved by tests using all the materials in the adopted proportions and consistency, that the mortar or concrete sets up and hardens properly. One notable exception to this rule is in the case of concrete laid in sea water, where tests have shown very conclusively that fine sand must never be used.

If fine sand must be adopted for concrete, a smaller proportion of it may be used with reference to the stone of the concrete than with coarse sand, because the finer sand makes a larger bulk of mortar, and the small grains fit more readily between the stones of the coarse aggregate. In the blocks made for the permeability tests described, the 1:3:6 concrete with the coarse No. 1 sand contained only a slight excess of mortar, not much more than was absolutely necessary to completely fill the voids, while the specimen mixed in the same proportions by dry weight with the very fine No. 3 sand had a noticeable excess of mortar, so much as to actually increase the bulk of concrete nearly 8 per cent. This excess came to the surface, although the concrete, which was mixed wet, was rammed scarcely at all. In practice this principle has resulted in requiring proportions with as little sand as in a 1:2:6 mix if the sand is fine, whereas 1:3:6 would have beeen necessary with a coarse, gravelly sand.

From these somewhat general observations and the results of tests we may summarize the following more important guides to selection of sand:

Coarse sand is always best for a rich mortar; for a lean mortar a small admixture of fine sand with the coarse is beneficial; water-tight concrete appears to require a larger percentage of fine grains than is necessary for maximum strength; if very fine sand must be used for mortar or concrete, it must be excessively rich in cement, and the sand must be tested for setting qualities; if the sand is fine, a smaller quantity may be used in concrete in proportion to the stone; to choose between two sands, make each into a mortar with cement in the required proportions, and for maximum strength, select the one producing a smooth mortar having the smallest volume.

MUNICIPAL MATTERS IN COURT

Kaw River Widening—Mayor in Contempt of Court—Bribery of Aldermen—Bitulithic in Baltimore—Louisville Water Company—No Restriction of Garbage Collection—Responsibility for Failure of Water Supply.

Widening of Kaw River Prevented.

Judge J. C. Pollock, of the federal court, has granted a restraining order against the Kaw Valley drainage board, at Kansas City, which wished to issue two series of bonds for river improvements—one for $200,000 and another for $325,000. The injunctions were brought by the Kansas City Stock Yards company and several railroads, whose holdiings would have been affected by the widening of the Kaw river.

Candidacy for Mayor Considered Contempt of Court.

Justice Brewer, of the supreme court of the United States, has allowed a writ of error to the Kansas supreme court in the case of Mayor W. W. Rose, of Kansas City, Kas., and ordered a stay of proceedings by the Kansas court. The writ was allowed on a petition from Mr. Rose, in which he seeks to have the federal court review the action of the state court in imposing a fine of $1,000 upon him for contempt in becoming a candidate for mayor a second time after he had been ousted by the state court on a charge of failure to execute the state liquor law. The contempt verdict provided that Mr. Rose should be imprisoned if the fine was not paid within twenty days. Justice Brewer's action will have the effect of preventing either the collection of the money or the enforcement of the imprisonment penalty until the federal court can investigate the matter after convening next October.

New Rochelle Aldermen Accused of Soliciting Bribes.

Charges preferred by D. A. Reyonlds, vice-president of the State Line Telephone company, resulted in the arrest of four aldermen at New Rochelle, N. Y., July 13, for bribery. It is alleged that the aldermen demanded $1,000 to $3,000 for granting a franchise to the Reynolds company.

Bitullthic Pavement in Baltimore.

In an opinion handed down by Judge Stockbridge in the circuit court July 5, he declared void the contract made by the city of Baltimore, Md., with the Warren Brothers Co. for laying bitulithic pavement on Twenty-fifth street, from the York road to Oak street, because after proposals were asked for asphalt blocks, bitulithic and vitrified brick, it was the duty of the city to award the contract to the lowest responsible bidder for any one of these three kinds of paving, provided only that each bidder was responsible. In this case the lowest bid was for vitrified brick paving. In the opinion of the court, competition was abandoned when the award was made for paving the street with bitulithic. This was the only one of the questions raised in the suit which was decided against the city and the Warren Brothers Co., but on account of the contract being improperly awarded, Judge Stockbridge granted an injunction restraining the laying of bitulithic. He held that the city might have made the contract for bitulithic directly with the Warren Brothers Co., as it has the right to contract for a patented article. Judge Stockbridge held that the laws under which the paving was being done were valid.

Louisville Owns Water Company's Stock and Can Borrow on the Plant.

An opinion was handed down by Judge Shackleford Miller, July 11, in the injunction suit of George Gaulbert against the city of Louisville, the waterworks board, and the water company, to test the validity of the proposed issue of $1,000,000 in bonds for the completion of the filter plant and the taking up of the water company's old mortgage bonds. The suit was brought for the purpose of establishing the validity of the bond issue, and was a friendly litigation. The plaintiff alleged that the bond issue was illegal, since the water company is now a municipal corpo-

ration, and could not legally issue mortgage bonds without the consent of the people, given by a two-thirds vote in an election held for that purpose.

Judge Miller holds that while the city owns all the stock in the water company and regulates it as a municipal corporation, it does not follow that the waterworks board and the sinking fund commission can not permit the company to issue mortgage bonds. He holds that the lien is upon the company's plant and property, and is a different matter from a debt which is a charge upon municipal moneys in general. The payment of the debt is provided for otherwise than by relying on the city, and so it escapes the prohibition of the constitution, denying cities the right to incur indebtedness in any year greater than the revenue from municipal source of income for that period. The water board, while under municipal control, is a separate corporation, and the demurrer of the plaintiff to the suit is sustained.

Ohio Cities Can Not Restrict Garbage Collection.

A decision was rendered by Judge B. G. Young, of the common pleas court, July 5, in the case of Charles Foster against the city of Marion, O., in which the plaintiff asked for a writ of mandamus to compel the board of public service and the superintendent of the garbage plant to accept garbage which he hauls to the plant. A demurrer to the petition was made by City Solicitor Hoke W. Donithen, who claimed that the writ does not state facts sufficient to constitute a cause of action, and asserted that the plaintiff, not being a taxpayer, has no right to bring a suit of this kind. Judge Young overruled the demurrer, and said that while the city council or board of public service has the right to require garbage collectors to pay licenses, and to require them to obey certain rules and regulations, it has not the right to restrict the garbage collection to one man. The city solicitor will appeal to the circuit court.

The Liabilities of Water Companies for Fire Losses.*

BY EDWIN R. SUNDERLAND, M. A., PROFESSOR OF LAW, UNIVERSITY OF MICHIGAN. ANN ARBOR.

It is a general principle, of very wide application, that a municipal corporation, in the absence of a statute, is not obliged to undertake the execution of governmental functions respecting the health, peace or property of its citizens. Nor is such corporation liable for the insufficient or negligent execution of such functions in case it undertakes to perform them. The ground of this exemption is that the municipality, in these matters, exercises discretionary powers conferred upon it by the state, and acts, not for itself in its corporate capacity, but for the general public as an agent of the central government.

A city, authorized to equip and maintain a fire department, to appoint and remove its officers, and to make regulations respecting their conduct and the management of fires, may or may not undertake to exercise that authority; and in case it does do so, it is not liable for losses suffered by property owners by reason of defective apparatus, insufficient equipment, or the negligence of the firemen employed. It is deemed that the corporation is here engaged in the performance of a public service, from which it derives no special benefit in its corporate capacity; and the members of the fire department, when acting in discharge of their duties, are in effect public officers, and not servants or agents of the city for whose conduct the city can be held liable. In an early case in Indiana, Brinkmeyer vs. City of Evansville, it was sought to evade this general rule on the ground that while it was discretionary with the city whether or not to undertake the maintenance of a fire department, yet when once the city had exercised its discretion by undertaking to give protection against fire, all else became mere ministerial duties, and the city was bound at its peril to make that protection adequate. But the court refused to impose upon the city any such liability.

The same doctrine has been repeatedly affirmed respecting the non-liability of cities, which own and operate water works, for failure to adequately supply all parts of the city with fire hydrants, and for negligence in maintaining an insufficient pressure for fire purposes. It seems to be conceded that the supplying of water for general fire purposes is a discretionary, governmental function, as distinguished from one which is purely ministerial and necessarily incident to the corporate life of a municipality. Perhaps no better statement of the difference between these two classes of functions has been given than that of Judge Gray in Springfield Insurance Co. vs. Keeseville, where he says:

> The distinction between the public and private powers conferred upon municipal corporations, although the line of demarcation at times may be difficult to ascertain, is generally clear enough. * *
>
> * When we find that the power conferred has relation to public purposes and is for the public good, it is to be classi-

*Extracts from a paper in the Michigan Law Review.

fied as governmental in its nature, and it appertains to the corporation in its political character. But when it relates to the accomplishment of private corporate purposes, in which the public is only indirectly concerned, it is private in its nature and the municipal corporation, in respect to its exercise, is regarded as a legal individual. In the former case, the corporation is exempt from all liability, whether for non-user or mis-user; while in the latter case, it may be held to that degree of responsibility which would attach to an ordinary private corporation.

And it was held that, under this rule, the village of Keeseville was not liable for damages caused by fire in consequence of its negligent failure to maintain sufficient water works.

The same rule has been applied in many similar cases, and it has invariably been held that the municipality was not liable for loss by fire due to such negligence on its part. Thus in Tainter vs. Worcester, where the city had cut off a street hydrant near plaintiff's mill because of her failure to pay water rates, by reason whereof her mill was lost by fire, the court said:

> The protection of all the buildings in a city or town from destruction or injury by fire is for the benefit of all the inhabitants and for their relief from a common danger; and cities and towns are therefore authorized by general laws to provide and maintain fire engines, reservoirs and hydrants to supply water for the extinguishment of fires. * * * The city did not, by accepting the statute and building its works under it, enter into any contract with, or assume any liability to, the owners of property to furnish means or water for the extinguishment of fires, upon which an action can be maintained.

The very elaborate opinion in Mendel vs. City of Wheeling, containing a full citation of authorities, lays down the same rule, which is also followed in Wright vs. City Council of Augusta, and in other cases which it is unnecessary to mention.

Nor can the city by contract render itself liable for failure to furnish an adequate supply of water, for such a contract would tend to restrict the discretion of the municipality beyond the scope of the charter, and would therefore be void.

It being clear, then, that a municipal corporation is not liable, either in contract or tort, for fire losses due to its negligent failure to furnish a proper public water supply, does the same immunity attach to a private corporation under contract with the municipality to provide water for general fire purposes?

It may be said, by way of introduction to the main question, that a water company which contracts directly with a consumer to furnish him an adequate water supply for fire purposes, is liable for such fire losses as may be sustained by the premises by reason of a breach of the contract. In Middlesex Water Co. vs. Knappmann Whiting Co. the water company had expressly contracted with the defendant to furnish it with water suitable for drinking purposes and other domestic uses, and for use in steam boilers, and with a sufficient pressure for fire purposes. The defendant's factory caught fire and was destroyed because of the failure of the water company to supply water according to its contract. And the water company was held liable for the loss, notwithstanding that the failure was due to no negligence on its part, but wholly to an unforeseen and unavoidable accident. A similar contract was held to create a like liability in Middlesex Water Co. vs. Sawyer. So in New Orleans, etc., Co. vs. Meridian Water Works Co. the plaintiff contracted with defendant for a full, adequate and sufficient supply of good, pure water, not less than sixty pounds pressure, for all purposes for which water might be needed or used at the plaintiff's shops. And it was held that plaintiff might show by legal evidence that the furnishing of water for fire purposes was, under the circumstances of the case, within the purview of the contract, and if that were proved, the plaintiff might recover the amount of the loss by fire due to insufficient pressure.

In each of the cases just referred to, however, there was a contract between the property owner and the water company, for a valuable consideration moving from the former to the latter, and hence there was no question of the legal right to bring an action for the breach. But the situation now to be discussed is radically different, in this, that the contract is made by the municipal corporation with the water company, and an individual property holder attempts to sue for losses resulting from a breach of it. The specific question presented is: In this class of cases, is it a fatal objection to an action *ex contractu* that the plaintiff is a stranger to the contract?

The earliest American case on the general question of the liability of water companies for losses due to fire, is Nickerson vs. Bridgeport Hydraulic Co., and the court there held that the want of privity was fatal to the action. The court said:

> The most that can be said is, that the defendants were under obligation to the city to supply the hydrants with water. The city owed a public duty to the plaintiffs to extinguish their fire. The hydrants were not supplied with water, and so the city was unable to perform its duty. We think it is clear that there was no contract relation between the defend-

ants and the plaintiffs, and consequently no duty which could be the basis of a legal claim.

The year following the above decision, the same question came before the Supreme Court of Tennessee, in Foster vs. Lookout Water Co., and it was again held, without further discussion, that there was no privity of contract, and hence no right to sue, the Nickerson case being cited and approved. The Supreme Court of Georgia, in Fowler vs. Athens City Water Works Co., based a similar conclusion on the same ground. To the same effect are Beck vs. Kittanning Water Co., Boston Safe-Deposit Co. vs. Salem Water Co., and Wainwright vs. Queens County Water Co.

But the question can hardly be disposed of in this summary way, because privity, in the strict legal sense, is not always necessary as the foundation for a suit on a contract. This was recognized in Davis vs. Clinton Water Works Co., where the plaintiff sought to recover damages for a loss by fire due to defendant's failure to provide an adequate fire pressure under its contract with the city. The court sustained a demurrer to the petition, saying:

It is a rule of law, familiar to the profession, that a privity of contract must exist between the parties to an action upon a contract. * * * Exceptions to this rule exist, which must not be regarded as abrogating the rule itself. Thus, if one under a contract receives goods or property to which another, not a party to the contract, is entitled he may maintain an action therefor. So the sole beneficiary of a contract may maintain an action to recover property or money to which he is entitled thereunder. In these cases the law implies a promise on the part of the one holding the property or money to account therefor to the beneficiary. Other exceptions to the rule, resting upon similar principles, may exist. The case before us is not an exception to the rule we have stated. The plaintiff received benefits from the water thus supplied in common with all the people of the city. These benefits she receives just as she does other benefits from the municipal government, as the benefits enjoyed on account of improved streets, peace and order enforced by police regulation, and the like.

While there is the greatest confusion among the cases on the question of the right of a third person to sue on a contract, the above statements by the Iowa court may safely be declared incorrect. In fact, it states no real exception to the rule at all. Of course, one may sue on an implied contract to recover property held by another to which he is entitled. Such an action is an ancient and well-known common law proceeding, and is based, not on the contract by which the defendant obtained the property, to which contract the plaintiff is a stranger, but on the original liability arising out of the possession by the defendants of the plaintiff's property. The contract which the law implies is an original contract between the plaintiff and defendant. Where, then, is there any exception to the general rule requiring privity?

The leading case on the general question of the right of a third party to sue on a contract, is Vrooman vs. Turner. In this case the court laid down a rule that there were two requisites essential to the right, (1) an intention on the part of the promisee to secure some benefit to the third party, and (2) some privity between the promisee and the party to be benefited, and some duty or obligation owing from the promisee to the third person which would give the latter a legal or equitable claim to the benefit of the promise. Respecting the necessity of the first of these requisites there is practical unanimity of judicial opinion. As to the second requisite there is much conflict. Many authorities hold that it is wholly unnecessary.

A number of the cases upon the liability of water companies for losses by fire, refuse to allow the plaintiff to recover on the contract, on the ground that there is no intention on the part of the promisee (the city) to secure a benefit to the property owner. This view is expressed in Akron Waterworks Co. vs. Brownless, House vs. Houston Waterworks Co., Bush vs. Artesian Hot and Cold Water Co., Eaton vs. Fairbury Waterworks Co., Wainwright vs Queens County Water Co., and Wilkinson vs. Light, Heat and Water Co. In these cases the contracts merely provided for the supplying of water for general fire purposes.

But on this point the courts of Kentucky, North Carolina and Louisiana take a directly contrary view. In Gorrell vs. Greensboro Water Supply Co., Clark, J., in delivering the opinion of the court, said:

It is true, the plaintiff is neither a party nor privy to the contract, but it is impossible to read the same without seeing that, in warp and woof, in thread and filling, the object is the comfort, ease and security from fire of the people, the citizens of Greensboro. * * * The benefit to the nominal contracting party, the city of Greensboro, as a corporation, is small in comparison, and, taken alone, would never have justified the grants, concessions, privileges and payments made to the water company. Upon the face of the contract, the principal beneficiaries of the contract in contemplation of both parties thereto were the water company on the one hand, and the individual citizens of Greensboro on the other. The citizens were to pay the taxes to fulfill the money consideration named; and furnishing the individual citizens with adequate supply of water, and the protection of their property from fire, was the largest duty assumed by the company. * * * Did the people of Greensboro have just cause to believe that by virtue of that contract they, as well as the cor-

poration, were guaranteed a sufficient quantity of water to protect their property from fire; and did the water company understand that it was agreeing, for the valuable consideration named, to furnish a sufficient quantity of water to protect private as well as public property from fire? The intent is to be drawn from the instrument itself, and on its face there can be no doubt it was contracted that the water supply should be sufficient to protect public as well as private property. If so, it follows that when by breach of that contract, private property was destroyed, the owner thereof, one of the beneficiaries contemplated by the contract, is the party in interest, and he, and he alone, can maintain an action for his loss.

And similar views are expressed in Graves County Water Co. vs. Ligon, Duncan vs. Owensboro Water Co., and Paducah Lumber Co. vs. Paducah Water Supply Co.

But there is another group of cases requiring attention. To preclude the courts from taking the position that the property owners were not the intended beneficiaries under contracts the express provision that, in case the water companies neglected to supply sufficient water for fire purposes, as provided for in the contracts, they should be liable in damages to all persons whose property was injured by reason of the inadequate supply. This, of course, rendered impossible the contention that the property owners were not intended to be beneficiaries. But the courts then took refuge in the second of the requisites indicated in Vrooman vs. Turner, namely, the absence of any duty or obligation owing from the city to the property owners, which would support an action by the latter against the water company.

Phoenix Insurance Co. vs. Trenton Water Co. is a typical case. The plaintiff sued the water company for a fire loss due to the company's breach of contract with the city, basing its right to sue on the ordinance granting the franchise, which provided: "Should said water company * * * fail to furnish a reasonable or adequate supply of water to extinguish any fire, then it shall be liable for all damages occasioned by all such fire or neglect." But the court refused to allow a recovery, on the ground that it was not necessary, to entitle a third person to sue on a contract, that there should be some debt or duty owing by the promisee to the third party, citing Vrooman vs. Turner. "In the case at bar," said the court, "the contracting parties were the city of Trenton and the water company. The insurance company is the third person suing and wanting to obtain the benefit of the promise of the water company made to the city. But an essential element is lacking. The city owes no legal duty to the insurance company to furnish water with which to extinguish fires. * * * Conceding that it stands subrogated to whatever right the assured had, what are his rights in a case of this sort against the water company? None whatever."

The same doctrine was subsequently approved by the Missouri supreme court, in Howsman vs. Trenton Water Co. Mott vs. Cherryvale Water Co. is based on the same doctrine, though it is not so fully stated. It was there held that since the city, had it owned the waterworks, would not have been liable for such damages, there was no legal obligation owing from the city to its property holders which would make a contract of this kind between the city and the company, available to the individuals who owned property in the city. And the supreme court of Iowa announced the same rule in Becker vs. Keokuk Waterworks Co. The court, in effect, said that the contract was ultra vires, but it seems clear that the court meant simply that the relation of the city to the taxpayers was such that the city could, by contract, confer any rights upon them against the water company. This principle seems to be an essential ground of the decision in Wainwright vs. Queens County Water Co. and in Boston Safe Deposit Co. vs. Salem Water Co., and was one of the grounds in House vs. Houston Waterworks Co., Eaton vs. Fairbury Waterworks Co., and Vanhorn vs. City of Des Moines, though some of these cases did not contain the special contract of liability to taxpayers.

If, as these cases hold, the second requisite of Vrooman vs. Turner is necessary, they are probably rightly decided, although there might still be a question whether there is not such a duty owing from a city to its property-owning citizens as will give them the right to sue on a contract made for their benefit.

However, if the second requisite of Vrooman vs. Turner is not necessary, it would seem that the group of cases above cited rests upon a very questionable foundation. The two Missouri cases of Housman vs. Trenton Water Co. and Phoenix Insurance Co. vs. Trenton Water Co., have already been discussed. These were both decided for the defendant on the ground that there was no duty or obligation owing from the promisee to the plaintiff, the court citing and quoting Vrooman vs. Turner.

As must be apparent from the discussion of the Kentucky, North Carolina and Louisiana cases, supra, those courts likewise hold that the second requisite of Vrooman vs. Turner is wholly unnecessary in order to authorize an action against the water company by a taxpayer.

Our conclusion on this branch of the

question is, although the discussion has necessarily been very brief and fragmentary, that the better rule does not require any duty or obligation owing from the promisee to the third person, and that when once it appears that a contract was intentionally made for the primary benefit of a third person. that person is ipso facto entitled to sue upon it.

It has been attempted, in several cases, to base the action against the water company on tort, so as to avoid the technical difficulties incident to an action on the contract. But this theory has received little support from the courts. In Fitch vs. Seymour Water Co., it was contended by the plaintiff that the relation between the city and the water company was not in its nature contractural. but was in fact founded upon a franchise and was therefore a relation created by law under the power conferred on the common council by the constitution and laws of the state. Hence the obligation resting upon the water company to furnish sufficient water for fire protection had all the binding force of a statutory enactment, and for a breach of this public duty the water company was liable to any inhabitant of the city who suffered damage thereby. But the court neld that the ordinance which gave effect to the contract with the water company was not one which the city was under obligation to enforce, since in enacting it the city moved in its governmental capacity. Therefore no liability could accrue against the city for failure to enforce it. and it followed that the ordinance imposed no public duty upon the water company appointed by the city to carry out the provisions of the ordinance. The only obligation, then, was one based strictly on the contract with the city. The same conclusion was reached in Fowler vs. Athens City Waterworks Co., and in Wilkinson vs. Light, Heat and Water Co. The case of Fisher vs. Greensboro Water Supply Co. holds that an action in tort will lie. but upon reasoning which seems very loose and unsatisfactory.

One other important case demands attention. In all the cases heretofore examined, the loss was suffered by an individual taxpayer. In the very recent case of Ukiah vs. Ukiah Water Co., the property of the city itself was damaged by fire by reason of the failure of the water company to furnish a sufficient supply of water. This would seem, on first view, to eliminate the question of privity, and to relieve the case of all the difficulties which we have been discussing. But the court held that the water company was under no liability to the city for the loss of its property, notwithstanding that such loss had occurred by reason of the company's failure to keep its contract with the city. "Doubtless." said the court, "a water company may so bind itself by contract with a person to furnish him water for the extinguishment of fires as to render itself liable for the value of property of such person destroyed by fire, by reason of its failure to furnish him a sufficient supply of water. It may be assumed here that it is within the power of a municipality as a property owner, to enter into such a contract with a water company for the protection of the property which it owns as a legal individual, but it certainly needs something more than evidence showing an accepted service for general fire purposes to establish such a contract. and the evidence here shows nothing more."

Aside from an action for damages, the only further remedy as against any one would be a rescission of the contract at the suit of the city. In Light, Heat and Water Co. vs. City of Jackson, the court said: "The remedy by rescission, which the courts are reluctant to afford when adequate damages for breach of contract may be recovered at law, is peculiarly appropriate in cases of this character." But it is beyond the scope of this article to consider the conditions under which the remedy is available.

It must be very clear from this brief discussion of the liability of water companies for fire losses, that the question is merely one phase of the larger question respecting the right of a third person to sue upon a contract. There has been no attempt here to treat that vast and complex subject systematically. I have merely tried to analyze the cases directly touching the special case of the right to sue water companies, and to suggest the obvious merits and defects of the arguments upon which they rest.

ELECTRIC LIGHTING

Municipal Light in Wisconsin—Street Lighting.

Municipal Lighting Plants in Wisconsin.

Statistics on municipal ownership of electric light plants have been compiled by Edward Bradford Smith, for the legislative reference department of the Wisconsin free library commission. He says:

The first municipal electric light plant in Wisconsin was established at Bayfield in 1889, five years after the beginning of the electric lighting business in this state. At that time there were thirty private plants in operation. The latest figures, those of last March, show forty-six municipal and 123 private plants in the state.

Of the 123 private plants thirty-eight are in places of less than 1,000 population, which is true also of thirteen of the forty-six municipal plants. The cities had villages of the state having municipal plants are as follows:

Bayfield, Columbus, Fort Atkinson, Marshfield, Mazomanie, New London, Oconomowoc, Plymouth, Reedsburg, Stoughton, Two Rivers, Algoma, Arcadia, Narron, Black River Falls, Blair, Blanchardville, Boscobel, Cedarburg, Clintonville, Colby, Cumberland, Elroy, Elkhorn, Evansville, Fennimore, Florence, Grantsburg, Rice Lake, Greenwood, Independence, Hudson, Jefferson, Kilbourn, Monticello, New Glarus, Princeton, Richland Center, River Falls, Sauk City, Shawano, Spring Green, Sturgeon Bay, Thorp, Whitehall, Waupun.

Of these the first eleven have the electric light plant operated in connection with the municipal water works. Only one plant, that in Hudson, is leased to a private company.

The strength of the municipal ownership movement is in the cities of from 1,000 to 10,000 inhabitants. Wisconsin is one of the twenty-four states of the union which have no cities of over 10,000 population with municipal electric plants. In the last twenty-five years the number of municipally owned electric light plants has increased from one to 1,050 and the number of private plants from seven to 3,234; that is, in 1881 the municipal plants were nearly 13 per cent. of the whole number of plants, while in 1905 the municipal percentage had arisen to over twenty-four.

This is materially increased in the six months of 1906 now elapsed. During the last twenty-five years, too, thirteen plants have changed from municipal to private ownership, but the balance was more than made good by the change of over 170 private plants to municipal ownership. Among these latter were the plants of nine Wisconsin cities, Oconomowoc, Bayfield, Cedarburg, Florence, Fort Atkinson, Jefferson, New Richmond, Plymouth and Two Rivers.

Street Lighting.*

BY HAYDN T. HARRISON, M. I. E. E.

The antipathy which engineers have so far shown to the actual measurement of street illumination is, in the case of gas engineers, and. to a smaller extent, in the case of electrical engineers, due to the fact that they are in the habit of stating the value of a lamp as the candle power which it will give when measured in the best position and without any globes or lanterns; therefore, when measuring street illumination. a figure is generally obtained much lower than that claimed.

For instance. a Welsbach mantle consuming from 3.5 to 3.75 feet per hour is generally stated as 70 c. p., whereas the very large number of measurements I have made during the last few years have shown that the average candle power derived, when measured in the street, is 35. Again. a 200-volt ½-ampere "A" type Nernst lamp, according to the makers, gives 70 candle power (heffner units); in practice I have found them equal to 37 candle power.

Again, a 500-watt direct-current open type arc lamp is generally called a 1,000 c. p. lamp; whereas Mr. Bradley's tests and my own go to prove that they average 600 candle power. Another example is the new gas lamps in Fleet street, which were claimed as 200 candle power. whereas the actual measurements I have made prove that they average 135 candle power.

Another example is the much advertised gas lighting in Kingsway and Aldwich. The gas journals are continually referring to the lamps used as 1,000 candle power, whereas the average of a large number of photo-metric measurements made by myself and others prove that the average candle power in the street is 515.

In order to arrive at any decision as to the degree of illumination which may be considered efficient for various streets. it is necessary to decide first the units in which the value of illumination should be specified. The mean illumination of a

*From a paper before the Institution of Electrical Engineers.

street cannot be ascertained from measurements of candle power, unless these are taken at a large number of different angles; moreover, it is necessary to state the height and distance of the lamps, in order to judge the illumination derived.

In 1892 Mr. Trotter read a paper before the Institution of Civil Engineers which dealt very fully with the matter, and his paper is even now probably the most complete treatise on the subject extant. Mr. Trotter used an illumination photometer devised by himself, in conjunction with Sir William Preece, by which the horizontal illumination at various parts of the road could be measured.

There are practical objections to the use of an illumination photometer as described by Mr. Trotter, which eventually resulted in my abandoning its use, but not until I had had practical experience of it for a period of about two years, and had obtained results of considerable value to me in my study of street lighting.

In order to judge the lighting of a street it is only necessary to know the minimum illumination at any point where light is required, because if that illumination is sufficient for the purpose, it obviously follows that it will be ample elsewhere.

It will probably be suggested that the value of the maximum illumination should also be measured and stated, in order that a diversity factor may be arrived at. The best lighted streets are those with the highest minimum illumination and with the lowest diversity factor, and, after having granted this definition, all that remains to be done in comparing the lighting of various streets is to state the value of the maximum and minimum illumination as measured therein.

But the unit of illumination, namely, candle-power feet, is not sufficiently definite, for it is obvious that when speaking of illumination we really mean the degree to which something is illuminated, and that will depend to a very large extent on the average angle at which the light strikes the various surfaces of that object.

In the design of instrument I recommend, an angle of 45 degrees has been chosen; if it had not been for practical reasons, I would have preferred a vertical screen. I abandoned the horizontal screen, which I used for many years, because the angle of incidence when measuring at a distance from the post became so large as to reduce the illumination on the screen to that point when it was difficult to get a balance, and, moreover, unless the screen was accurately leveled, considerable errors were liable to creep in; these faults made it practically impossible to measure the minimum illumination, which I consider the most important factor.

Other reasons of equal importance are that, owing to the great variation in the spectrum of lamps used for street lighting purposes, a flicker method of obtaining a balance is essential for accurate work, and an angle of 45 degrees is found more convenient in the design of this part of the apparatus, and that the illumination of vertical objects in a street is of equal, if not greater, importance than that of the road and pavement. Therefore, by stating the value of the illumination on a screen at an angle of 45 degrees, we are probably giving the most useful information for practical purposes. Moreover, the measurements obtained at this angle are as easily converted to measurement of candle power as would be the case if any other angle were used, and the fact that the candle power of the lamps in one direction only is measured simplifies this calculation considerably. The most convenient height for making the measurement I have found to be 4 feet.

Therefore, for the purpose of measuring and comparing the illumination of streets, roads or open spaces, I would suggest that the minimum and maximum illumination which can be derived at any point, be stated in units of candle power feet measured on a plane surface inclined to the vertical at an angle of 45 degrees.

I have, from various published statements, obtained the opinions of gas and electrical engineers as to the present-day requirements in this direction, and from tests made by myself and others am able to give a rough average of what actually occurs in practice.

From the valuable tests taken by Mr. Pearce at Manchester, I have extracted the following figures, which give an example of the lighting of the main thoroughfare of an important town (see Table I).

TABLE I.

Position.	Lamp.	Distance apart.	Minimum direct illumination.
Cheetham Hill Rd.	900-watt enclosed arc	76 ft	.62
Piccadilly	Intensified gas	58 ft	.38
All Saints'	600-watt enclosed arc	57 ft	.54
Albert Street	Intensified gas	102 ft	.14
Sackville Street	600-watt enclosed arc	66 ft	.30
Piccadilly	Incandescent gas	206 ft	.013

A much more interesting example in this neighborhood is that of Gorton, where Mr. Pearce has lately replaced 25 double Welsbach mantles, each taking 4 cubic feet of gas per hour, by 22 enclosed arc lamps giving 400 candle power each. The gas lighting in this case used to cost £150 per annum; the electric lighting is done for £176. Taking an average candle power for the lamps based on the figures given by Mr. Price, of Birmingham, and measurements made by myself elsewhere, the candle power will work out at 80 per post; therefore it will be seen from the following figures that the minimum illumination has been increased four times at an extra cost of 17 per cent. per annum:

Old System.—Incandescent gas, 80 candle power, 90 feet apart, minimum illumination (direct), .037.

New System.—Enclosed arc lamps, 400 candle power, 100 feet apart, minimum illumination (direct), .145.

As a final example, I proposed to take the much disputed City and Kingsway lighting. In the case of Kingsway, the length is 4,000 feet and the breadth 100 feet.

There are 51 high-pressure gas lamps, and the measurements I had made in October averaged 670 candle power on the lamps in good condition, and 450 on those which were in poor condition. The posts are staggered, therefore the maximum distance from any post would be 40 feet, where you would be deriving light from three sources, two of which would be available on a screen at an angle of 45 degrees, but, for the sake of comparison, I propose to consider one only. This works out as follows:

Kingsway.—High pressure gas, 515 candle power, 80 feet apart, minimum direct illumination, .206.

In the case of Fleet street, 12 10-ampere lamps in muranese globes have lately been replaced by 34 pairs of incandescent gas mantles.

In the case of the gas lamps, the two mantles are placed side by side; therefore, the minimum candle power measured is across the road, where it averages 80 candle power, and this will be the point at which the minimum illumination occurs, namely, at a distance of 30 feet.

The old arc lamps were at a distance of 137 feet apart, and, as they gave 680 candle power when measured at a distance of 30 feet, it can be taken for granted that 600 would be a safe average to take at the greater distance.

City, Fleet Street.—Old arc lamps, 137 feet apart, minimum direct illumination, .117. New gas lamps, 48 feet apart, minmum direct illumination, .08. The actual minimum illumination between the gas posts would be 48 feet apart, minimum direct illumination, .18.

I think I have now given sufficient opinions and examples to formulate some idea of both the past and present practice. The very figures which I have put before you show the diversity of opinion, as demonstrated in practice; it is therefore only possible to obtain a rough average, but nevertheless, this will form some basis to work on.

I do not propose to consider the more brilliantly lighted streets of Manchester, or the gas company's latest show in Aldwich and Kingsway, as there is little doubt that the illuminating of public buildings in the case of the former has been aimed at as much as, if not more than, lighting the streets; and the latter case, as far as one can judge, is an advertisement for the gas companies, the cost of which will probably never be disclosed. Therefore, I think we may take it that in most towns the minimum direct illumination is as follows (see Table II).

TABLE II.

Main thoroughfares, minimum direct illumination	.050 candle power feet
Side streets, minimum direct illumination	.025 candle power feet
Suburban streets, minimum direct illumination	.005 candle power feet

These figures are averaged from actual measurements made in the street, and not from the fictitious values often claimed, and it is interesting to note that in many places where electric light has been installed, these values have been exceeded, whereas the actual illumination obtained from gas mantles is generally much lower than that estimated by the representatives of the gas industry.

The usual test for the value of the minimum illumination is the possibility of reading a Bradshaw railway guide. I find, personally, that this is possible at an illumination equivalent to .05 candle power feet. With .005 candle power feet you can not recognize a face; in fact, can only just avoid running into anything. Mr. Trotter found moonlight to be .028 candle power feet in England near full moon; thus it will be seen that in the side streets of large cities the minimum illumination approaches full moon, but in the suburban street is less than one-fifth. Unless the value of illumination in any street exceeds, say, .015 candle power

feet, it could hardly come under the head of street lighting, but should be called "beacon lighting," as suggested by Mr. Trotter.

The remainder of my paper I intend to give up to discussing the possibilities of improving the existing state of affairs without increasing the cost in any way. It is now several years since I came to the conclusion that the efficiency of street lighting must be judged by the minimum illumination derived at any point. and I devised fittings to increase the light at that point. By far the most efficient of these, which is fully protected, is now being manufactured by the Reason Manufacturing Company, of Brighton. In designing these fittings, I took the following facts into consideration:

1. That the rays directed above the horizontal are useless, and therefore can be diverted up and down the street to increase the distant illumination.

2. If the posts are erected on the edge of the footpaths, the rays which would illuminate the adjacent houses or fields are practically useless, unless the houses have a reflecting value, which is very rarely the case.

3. The rays of light illuminating the street near the post should be of small value compared to those directed to a distance up and down the street, in order to obtain even illumination.

The above conditions, in short, mean that practically only a quarter of the mean spherical candle power is useful, and that the other three-quarters are wasted unless directed into the required direction. The extent to which this fitting succeeds is as follows:

The average candle power of the lamps measured from all parts of the street will be found to be 2.2 times the mean spherical candle power, and the maximum candle power measured over the width of the road some distance from the post is nearly three times the mean spherical, the minimum candle power measured adjacent to the post being equal to the mean spherical candle power of the lamps.

I have had to divide the source of light into two; in other words, to use two lamps in place of one.

One-half of the filaments or glowers of each of these lamps is enclosed in a specially shaped hollow hemispherical reflector, fixed at such vertical and horizontal angles that in those positions (as viewed from the street) where the reflectors are not in themselves increasing the illuminating value at the lamps to more than double the maximum of one lamp, the light of both lamps is allowed to shine. Thus, at no point does it decrease the light, and over the greatest area of the street the light is increased to the maximum above stated.

These reflectors are of glass blown on to a mold of the correct shape, and in such a way as to form a bottle, the inside of which is silvered; the opening is then hermetically sealed when fixing the cap; thus a reflector of about 88 per cent. efficiency is obtained. which efficiency is practically permanent.

In the reflector the whole of the hemispherical rays are deflected, whereas in previous designs in which the lamp passed through a hole in the center of the reflector, a great number of these rays were not utilized. Another point is that the lamps are in such a position that the maximum rays are used both in illuminating the distant parts of the street direct, and by means of the reflector.

These fittings are free from what is sometimes called "the bull's-eye" effect, as the maximum rays are not concentrated into anywhere near a parallel beam, but are spread over an angle of 20 degrees, and rays equal to twice the mean spherical candle power of the two lamps are spread over an angle of 40 degrees. which is generally the whole width of the road at a distance equal to twice the height of the post.

In order to ascertain the type of lamp to use for the purpose, when basing calculations on minimum illumination, it is necessary to know the candle power derived from the lamps at an angle of about 20 to 30 degrees below the horizontal, and about 10 degrees on the path side and 30 degrees on the road side, of an imaginary line drawn parallel to the curb; this is. of course, for posts erected on either side of the road, which is the present day practice.

The following table is based on the average of a large number of measurements made in the street under working conditions (average mean candle power of lamps 20 to 30 degrees below horizontal. and 10 degrees one side and 30 degrees the other side of the line drawn parallel to the street) (see Table III).

I would particularly call attention to Class 13, which appears unduly high. In my opinion this is due to the mantles being renewed at more frequent intervals. as it is based on measurements made in Fleet street which may be called without prejudice a test case.

It is now comparatively easy to set down the numbers of posts and fittings per mile necessary to obtain the minimum illumination generally provided for various classes of streets (see Table IV).

The foregoing table demonstrates several interesting points, the importance of which, I consider, cannot be overrated. They are as follows:

TABLE III.

Electric lamps.	Watts consumed.	Candle power at angles stated.
(1) Flame type	400	1.300
(2) Open type arc	500	500
(3) Enclosed arc	1.000	1.100
(4) Enclosed arc	600	550
(5) Reason fitting incandescent lamps	200	120
(6) Reason fitting incandescent lamps	120	70
(7) Reason fitting incandescent lamps	60	30
(8) Reason fitting Tantalum lamps	70	110
(9) Nernst lamps "A" type	100—120	40
(10) Nernst lamps "B" type	50—60	15
Gas lamps.	**Gas consumed per hour**	**Candle power at angles stated.**
(11) High-pressure mantles	30 c. f.	515
(12) High-pressure mantles	20 c. f.	215
(13) Intensified gas, two mantles (City)	7.5	130
(14) Two low-pressure gas mantles	7.5	130
(15) One low-pressure gas mantle	3.75	37
(16) One low-pressure gas mantle	3.2	32

TABLE IV.

Distance Apart of Lamps of Various Types to Give Required Minimum Illumination.

Type of lamp.	Main thoroughfares. Min., .05 c. p. f.		Side streets. .025 c. p. f.		Suburban streets. .005 c. p. f.	
	Distance apart.	Posts per 1,000 yards.	Distance apart.	Posts per 1,000 yards.	Distance apart.	Posts per 1,000 yards.
Electric flame	300 ft.	10	—	—	—	—
Open arc	200 "	15	—	—	—	—
Enclosed arc	300 "	10	—	—	—	—
"	200 "	15	300 ft.	10	—	—
Reason fitting	100 "	30	140 "	21	300 ft.	10
"	70 "	43	100 "	30	250 "	13
"	45 "	66	65 "	46	150 "	20
"	90 "	33	130 "	23	290 "	10
Nernst lamp	55 "	54	75 "	40	189 "	17
"	—	—	65 "	46	110 "	27
Gas Lamps—						
High pressure	200 "	15	300 "	10	—	—
"	120 "	25	180 "	17	—	—
Intensified	100 "	30	140 "	21	—	—
Ordinary	75 "	40	105 "	28	240 "	12
"	50 "	60	75 "	40	170 "	17
"	45 "	67	70 "	43	150 "	20

1. The use of large units of light for general street illumination is expensive, and should be avoided where possible.

2. The cost of maintenance is very often as high, if not higher, than the cost of electrical energy or gas; it must be borne in mind that in the foregoing table electrical energy is taken at 1½d. (3 cents) per unit—it is very often less than this for street lighting, in which case the cost of maintenance becomes a still more important factor.

In calculating the cost of electrical energy when using carbon incandescent lamps, I have taken the lamps as consuming 4 watts per candle power—which is reduced to 2 watts per candle power, or even less, by the Reason fitting; but, even if no special fitting had been used, four 10 c. p. lamps consuming 160 watts are, when placed at 20 feet apart, better than 160 c. p. lamps spaced at 80 feet, as the ratio of minimum illumination derived is 16 to 1, whereas the efficiency of the lamps is only 4 to 1.

The highly efficient incandescent types of lamps which are now being put on the market, such as tantalum and osmium, are much more suited for low voltage than high; these lamps, provided their lasting properties are improved, are eminently suited for street lighting, on account of their high efficiency and steady light-giving power.

I have, therefore, lately been experimenting with them connected in series, with most gratifying results, and trust shortly to be able to recommend the supply of these lamps for street lighting purposes. They will be low voltage (10 to 30), with thick filaments, intended to be run in series throughout the street, and controlled at the end of each series by a magnetic relay switch connected to the previous series, in a similar manner to that used for arc lighting by Mr. Robinson, of Hackney, and others.

A very simple cutout designed by myself prevents a fault in any lamp extinguishing the series.

In my calculations it is easy to see that I have not favored electricity in any way in taking the cost of gas at 2s. (48 cents) per 1,000 cubic feet. I have taken a price which only 12 towns out of 223 are able to charge, all the others being higher; whereas 1½d. (3 cents) per Board of Trade unit is higher than is being charged by a large number of electrical undertakings.

WATER SUPPLY

Cincinnati Water Service—High Pressure Water Service—Valuation of Waterworks—Cast Iron and Riveted Pipe—Expanding Water Systems.

Condition of Cincinnati's Water Service.

In compliance with the request of Mayor Dempsey, of Cincinnati, a communication was submitted to the board of public service, July 12, by John W. Hill, chief engineer of the waterworks department, regarding the condition of the water plant. Mr. Hill stated that he had made as rapid a survey of conditions as was possible. He described the water service of the city in its mechanical details, stating that the Front street station is required to pump all water from the river to the Eden Park and Third street reservoirs, where the distributing service begins.

The weak spot in the river pumping service is the condition of the engines which pump to the Eden Park reservoir. He says ample pumping capacity for the low service is supplied for the Third street reservoir. The total pumping capacity is approximately 46,000,000 gallons daily. A description of the engines, the dates of their installation, and their estimated capacities, is given. Each of the engines, except the auxiliary battery, is in bad working condition. None can be run at their full speed and to their full-rated capacity, nor is the situation such that any engine can be temporarily taken out of service to make the necessary repairs. He states that the Worthington engine will be almost, if not quite, as good as now when repairs are completed and will pump 11,000,000 gallons a day. The new engine recently purchased will enable them to increase the pumping capacity to nearly 50,000,000 gallons a day, which will admit taking out of service from time to time engines Nos. 7, 8, 9, 10 and 11 and putting them in good condition. Mr. Hill says there is at present practically no surplus capacity for the hilltops, and it is his purpose to make such repairs to the engines in the Eden Park and Hunt street stations as may be necessary from time to time.

Regarding the complaint made with reference to pressure at widely separated points, he reports the condition to be due partly to the heavy draft on the distributing mains, and partly to the closed or partially closed 36-inch stop valves at Eighth and Cleveland streets. He says he has been advised that they were partly closed during an attempt, about five weeks ago, to permit the new waterworks commissioners to connect the new with the old pipes. The valve stem is broken and it can not be operated until a safe time, and conditions, therefore, can not be improved. He says that if this valve is open, or nearly open, relief to the middle service can only be had by connection with the new mains. Facts with reference to this valve can not be had until it has been opened and examined. He has information to the effect that a 20-inch valve on Woodward street is partly closed. If correct, the whole supply from Eden Park reservoir is now and has been for some time drawn through a constricted system of pipes. Mr. Hill concludes his report as follows:

> While the overhauling and repairs of the Front street station and elsewhere will afford temporary relief, no permanent relief can be expected until the new works can be completed, which was authorized by the legislature about ten years ago.

The Philadelphia High Pressure Water System.*

BY F. L. HAND, PHILADELPHIA, PA.

The engine room at the pumping station is 68 feet wide by 140 feet deep, and contains seven large gas engines, each 300 brake horse power, and two small gas engines, each 125 brake horse power, making a total horse power of 2,350. To each of the large engines there is attached a pump direct connected and delivering 1,200 gallons of water per minute, and to each of the small engines there is attached a pump delivering 350 gallons of water per minute.

Each gas engine is of the vertical, three-cylinder, four-cycle type, made by the Westinghouse Machine Co., of Pittsburg, and erected by M. M. Muckle, Jr., & Co., contractors for the plant.

Each of the seven large engines weighs

*From a paper before the American Waterworks Association.

90,000 pounds, and each small engine weighs 35,000 pounds.

The pumps are double acting, triplex plunger pumps, 11½x12 for large pumps and 6½x12 for small pumps. The combined delivery of entire plant averages 10,000 gallons per minute under pressure of 300 pounds per square inch. The pumps were all made by the Dean Pump Co., of Holyoke, Mass., each large pump weighs 49,000 pounds, and each small pump weighs 25,000 pounds. The contract price for installing the entire plant, was: building, $82,000; nine gas engine units and pumps, two Rand compressors, two 220-volt direct current generators, 8 air tanks, electrical work, etc., $178,000; thus making a total for power plant, complete, $260,000.

The fuel used for operating the engines is gas, which is obtained from the United Gas Improvement Co. The supply of gas is well protected from failure. The supply to the station connects with every distributing station (seven in number) belonging to the gas company, thus providing for accidents to any one or number of their plants. Even should gas holders give out at one or more of their distributing stations, gas can be obtained by by-passing said holders.

This certainty of the gas supply is a very strong feature of the station, as it obliterates defects of banked fires, etc., in steam plants, and electrical defects, either in conduits, dynamos, short circuits, etc., where engines and pumps are electrically driven, neither of which are usually relayed. The essential feature of a central power station for fire fighting purposes is necessarily founded on the basis of assurety which literally means that more than one method must be in existence to accomplish the same result. In this respect the pumping station is very strongly fortified, thus rendering mechanical movements relayed in such a manner that entire failure is eliminated. The gas supply to the station is drawn from a 30-inch trunk line on Front street, a distance of 150 feet from the power station.

A 16-inch supply main extends from the 30-inch main on Front street to the interior of the station, this 16-inch main being controlled by a street valve on the south sidewalk of Race street, distance 40 feet from station. For greater security it was thought best to locate this 16-inch main on the sidewalk, thus keeping it entirely free from disturbances arising from the street work done by the different corporations, and likewise protecting the pipe against settlements from traffic, sewer, cave-in, etc.

From this 16-inch gas main leading into the station we have the gas lines leading up to the engines. These are 12, 10 and 8-inch lines. These pipes are all located along the walls, thereby rendering accidents happening to same from traveling crane very remote.

The gas furnished averages 23 candle power, and is nearly uniform in quality and pressure, the average maximum pressure being 32-10 and the minimum pressure 22-10. The average calorific value of the gas is B. t. u. per cubic foot.

The ignition of the mixture under compression is accomplished by an electric igniter of the make and break type, removable for cleaning, in the form of a single plug; to render operations assured all engines are furnished with duplicate igniters and by means of a throw-over switch the ignition currents may be transferred to the reserve igniter on any cylinder. Owing to the fact that the explosive mixture of gas and air reaches on combustion an average temperature of 2,600 degrees, it is necessary to use cooling water for cylinder heads, valves, and exhaust mains, otherwise the cast iron, whose melting point averages 1,800 degrees, would disappear. This cooling water is controlled by a single valve, and for assurety on cooling water the plant is capable of obtaining it from three different sources, each separate from the others.

All the engines are started through the agency of compressed air, which is stored at 200 pounds pressure. There are eight seamless steel tanks, each sixteen inches in diameter by fifteen feet long; with total storage capacity of 164.40 cubic feet.

The two small gas engines run in addition to the air compressors, two 7 1-2 k. w. generators, both compressors and generators being belt driven from the small engines, and both small engines can be operated independent of the pump. These small pumps, as before mentioned, each discharge 350 gallons per minute under any pressure up to 300 pounds per square inch, and can be used more economically for saturation after a fire has been conquered than a large 1,200 gallon pump. As a comparison of cost, the small pump can be operated under 300 pounds pressure for two dollars per hour, whilst the large pump for the same time operated would cost five dollars per hour, thus meeting the emergency at a saving of three dollars per hour.

The ignition current constitutes one of the most vital points in gas engine operation. The assurety of the fuel supply, heretofore mentioned, must, for successful operation, be backed up with non-failing ignition currents, and likewise jacket water supply. Each engine is furnished with an igniter cabinet located near the engine throttle upon the upper

galleries, and three sources of current are available for ignition of the gas at each cabinet, and are there controlled by switches, first a 220-volt Edison current, taken from the street conduits, can be utilized and put through a rotary transformer; second, a current can be regularly supplied from a duplicate set of 7 1-2 k. w. 22-volt direct current generators belted to the small engines (these generators are in duplicate). This voltage is reduced to 110 volts by individual motor generators.

The third source of current supply is from the six cells of Edison Lalande primary battery type R. R. which are located inside of each igniter cabinet..

As a guard against improper movement of switches on igniter cabinets it may be well to state that everything about the cabinets is so arranged that the engine operator can not by any combination of the switches get the Edison current and the station current thrown together or either of these into the primary battery. The wrong position of a switch may stop or affect the working of that particular engine, but can not interfere with any other.

The pumping machinery was constructed to meet special specifications, in which a considerable improvement over standard practice was contemplated. The general design is that of the standard triplex, double acting, inside packed type of single geared plunger pump, made by the Deane Co., of Holyoke, Mass. The large vertical direct double acting pumps are 11½ x12, with a capacity of not less than 1,200 gallons per minute at 40 revolutions per minute, all pumps geared in a ratio of five to one. The small pumps are similar in design to the large ones, with 6¼x12-inch plungers, and each has a capacity of not less than 350 gallons per minute. The triplex design was selected because of the uniform discharge to be secured, which at the high pressure employed on the mains, becomes imperative; specially massive construction has been employed, together with composition bronze in all internal fittings to secure easy starting after a period of idleness.

The water ends are constructed in sections with unusually large valve areas. Suction and discharge boxes are cast separately from the pump barrels, which in turn are separate from the base.

The three resulting sections of the pump are united by bolted flanges, and the replacement of any part may thus be accomplished without disturbing the adjustment of the remaining parts. All moving parts of the pump are adjustable to compensate for wear. A striking feature is the provision of a motor-driven by-pass valve controlled, as previously described, by meas of an electric switch attached to the housing of the pump. When any unit is started this valve is left open, and when full speed is reached the motor valve is closed, which action diverts the discharge from the overflow pipe leading to the sewer to the discharge main connecting to the fire main system. This operation allows the pump to start up under friction load, and the discharge pressure is gradually increased to full working pressure during the closing of the valve, thus avoiding all shock to the machinery or system. It also does away with the friction clutch which otherwise would be necessary.

The water supply for the entire pipe system is fresh water obtained from the Delaware river. A three feet steel suction pipe extends into the river at the bulkhead line, the bottom of this suction pipe being seven feet below extreme low water mark, the end of which is fitted with a rod screen. The water passes through this suction pipe inside of building, and is there connected to each pump. The floor level of the pumping station is 12 feet above bottom of suction pipe in river, and 9 1-2 feet above bottom of suction pipe in the building. The maximum lift is 20 feet, the minimum lift, 10 feet, as recorded by vacuum gauges on the pumps.

The well built inside of the station to receive the 3 feet steel suction pipe contains also every system of pipes installed in the building, such as discharge main, suction and discharge connections to pumps, jacket water lines, sprinkler and electrical connections, etc., all of which can readily be reached by lifting the iron floor plates which cover the well. The above well thus affords an easy means of getting at all pipe joints without tearing up the cement floor in the engine room.

With 300 pounds pressure on the large pumps each delivering 1,200 gallons of water per minute requires 280 b. h. p. on the engine. The consumption of gas per minute under these conditions was 83 cubic feet, or 4,980 cubic feet per hour for 280 b. h. p., or 17.79 cubic feet per brake horse power per hour equals 12,008 heat units. Cost of operation per brake horse power per hour, 1.78 cents.

With 200 pounds pressure on the pump gauge the total brake horse power is 186.67, consumption of gas per minute 75 cubic feet, or 4,500 cubic feet per hour, or 24.11 cubic feet per brake horse power per hour, equal to 16,274 heat units; cost of operation per brake horse power per hour, 2.41 cents.

With 100 pounds on the pump gauge the total brake horse power is 93.34; consumption of gas per minute, 52 cubic

feet per hour, 3,120 cubic feet, or 33.43 cubic feet per brake horse power per hour, equal to 22,565 heat units. Cost of operation per brake horse power per hour, 3.34 cents.

Consumption of gas, no load, averaged 35 cubic feet per minute.

Small engines operating pump under 300 pounds pressure per square inch and discharging 350 gallons of water per minute requires 81.67 brake horse power, whilst the operation of the dynamo and air compressor (belt-driven off of small engine) requires an additional 15 brake horse power, making a total of 96.67 b. h. p. The consumption of gas per minute under these conditions is 34 cubic feet, or 2,040 cubic feet per hour, or 21.1 cubic feet per brake horse power per hour, heat units 12,243. Cost of operation per brake horse power per hour, 2.1 cents. Under a pressure of 200 pounds on the pump gauge including operation of dynamo and compressor, requires 69.45 b. h. p. gas consumption per minute, 26 cubic feet, or 1,560 cubic feet per hour, or 22.46 cubic feet per b. h. p. per hour, heat units, 15,161. Cost of operation per brake horse power per hour, 2.25 cents.

Under a pressure of 100 pounds on the pump, together with operation of a dynamo and compressor, requires 42.22 b. h. p. Gas consumption per minute 22 cubic feet, or 1,320 cubic feet per hour, or 31.26 cubic feet per brake horse power per hour, equals 21,101 heat units. Cost of operation per brake horse power per hour, 3 1-8 cents.

With pump out of service and small engines operating on dynamos and air compressor, requires 15 b. h. p. Gas consumption per minute 17 cubic feet, or 1,020 cubic feet per hour, or 68 cubic feet per brake horse power per hour, heat units, 45,900. Cost of operation per brake horse power per hour, 6.8 cents.

Operating Expenses for 1904.—Total hours run, large engines, 337 hours 3 minutes; total hours run, small engines, 197 hours 24 minutes; load on large pumps, 100 to 300 pounds water pressure; small engines run without load.

Total gas consumed for the year, 1,741,254 cubic feet, at one dollar per thousand. Cost, $1,741.25.

Gas consumed under following conditions:

	Cubic ft.
Official tests	778,749
Oil tests	172,566
Plant in service 9 times	145,116
Plant started on 32 alarms (service not required)	48,357
Experimental runs, compressing air, etc.	596,466
Total gas consumed	1,741,254
Total gallons of water pumped	27,110,200

Pea coal used in boiler for heating building, 126 1-2 tons, at $3.73 per ton; cost	$471.85
Electric lighting, Edison current	814.20
Electric ignition on engines, Edison current	21.80
960 lbs. No. 1 white waste at 7½c	72.00
Graphite and tallow for pump gears, 60 lbs. at 7c	4.20
Gasoline for igniters, etc., 12 gallons at 10c	1.20
Cost of oil for engines and pumps.	270.55

Cost of oil represents filling all crank cases in 1904.

Cost of oil, 1905, nothing.

SUMMARY OF OPERATING EXPENSES.

Gas for engine operations	$1,741.25
Coal	471.85
Electric lighting and power	836.00
Oils	270.55
Waste, grease, gasoline	7.07
Repairs to machinery	1.57
Furnishing office, floor coverings, beds, bed linen, tools, etc	700.00
Total operating expenses	$4,098.72

SALARIES OF STAFF.

Superintendent	$2,000.00
Two engineers, each $1,200	2,400.00
Four oilers, each $720	2,880.00
One mechanic, $900	900.00
One janitor, $600	600.00
Total	$8,780.00
Salaries	$8,780.00
Operating expenses	4,098.72
Total annual cost	$12,878.72 year 1904

Note the total annual cost of maintenance for year of 1905 was $12,000.00.

The economy of the high pressure fire service was clearly demonstrated at two conflagrations during the first year of its installation.

On Sept. 18, 1904, the plant was put in action on Alarm Box 26, Eighth and Market streets, right in the heart of the congested district. Figuring on the basis of one engine the following data is given:

Hours run on basis of one large engine, 8 minutes; hours run on basis of one small engine, 0 hours, 21 minntes.

Amount of gas used, 7,872 cu. ft., at $1.00 per thousand	$7.87
Three gallons of oil, at 26c	.78
One and one-half pounds of waste, at 7 1-2c	.11
Wages one engine, 1-2 hour	.14
Wages two oilers, 1-2 hour each	.17
Total	$9.07

Constant pressure on the pumps, 200 pounds; gallons of water pumped, 153,600; cost per thousand gallons, 5 9-10 cents.

The second conflagration was on Dec. 19, 1904. Alarm box 576, location Tenth and Walnut streets.

Hours' run on basis of one large engine, 19 hours, 6 minutes. Hours' run on basis of one small engine, 2 hours, 24 minutes. Maximum pressure on the pumps, 225 pounds. Minimum pressure on the pumps, 75 pounds.

Amount of gas used, 75,893 cu. ft., at $1.00 per thousand	$75.89
Six gallons of oil, at 26c	1.56
Four pounds of waste, at 7 1-2c	.30
Wages, one engineer, 7 hours	1.95
Wages, two oilers, 7 hours each	2.38
Total	$82.09

Total gallons of water pumped, 1,375,200; cost per thousand gallons, 6 cents.

Note the cost of pumping has not exceeded six cents per thousand gallons on all fires during the year of 1905.

Entire station put under way in 7 minutes.

Full pressure on pump, 300 pounds, in 45 seconds.

Average starting time, per unit, 1 minute.

Compressed air starting system fully adequate.

Each compressor able to run one large engine continuously, independent of storage tanks.

Total air pressure drop in starting, 9 units, with the compressor out, 97.9 pounds average, initial 200 pounds.

Time required to place on igniter, 4 minutes.

Gas supply clean, uniform and continuous.

Cost of power approximately proportionate to pumpage.

Total operating cost averaged 12 1-2c per 1,000 gallons pumped.

Cost at a large fire, 6 cents per 1,000 gallons pumped.

Entire plant capable of supplying fifteen 1 1-2-inch streams that may be concentrated on any block within the congested or protected district.

Special water battery wagon can handle six 3 1-2-inch lines of hose.

Average station pressure for an ordinary fire, 200 pounds.

Pressure drop in 3 1-2-inch hose, about 20 pounds per 100 feet.

In considering the pipe system, much care was exercised. Steel flanged pipe, cast iron flanged pipe, and extra heavy bell and spigot pipe all received careful study, along all lines. The available appropriation would not permit the use of steel main; its cost was excessive compared with the use of cast iron. Bell and spigot pattern of cast iron pipe was abandoned, owing to the multitude of lead joints, thus increasing the liability to leakage through bad caulking of joints, or through such a pressure as 300 pounds per square inch. A decision was finally made in favor of cast iron flanged pipe with a solid lead sleeve introduced every 250 feet. In adopting this I feel we have used good judgment, as we have not had one defect develop in the entire 8 1-2 miles of pipe system since it was put into service, three years ago.

Although the entire system has been subjected to a pressure of 300 pounds per square inch a great many times, in some cases for a steady period of five hours, and again is constantly subjected to pressures varying from 50 pounds to 300 pounds at almost all conflagrations, dependent on fire maneuvers, increasing or decreasing the lines of water in service, etc.

In designing the pipe service provisions were made for three fire boat connections along the Delaware river front, and six ways of circulating water, together with the introduction of many valves, so that in case of accident a minimum amount of the service would be thrown out of commission. Again, in laying the service a minimum depth of 7 feet was adhered to, the idea in this being to get below all service connections into buildings, etc., thus placing ourselves beyond disturbance in this direction. At the same time it gave us solid ground for pipe laying.

It will be understood that the three fire boat connections actually act as a relay water supply to the pipe system, and which is entirely independent of the pumping station. All sleeve and valve boxes are built large enough to permit any work in connection with sleeves or valves to be done without tearing up the street.

All pipes and fittings were subjected to a pressure of 800 pounds per square inch before accepted, then when laid all pipe were subjected to a water pressure of 400 pounds per square inch to test accuracy of bolt joints and caulking on sleeves, stuffing boxes on valves and connections to hydrants, etc., the portion of the line thus tested was then filled in and the ditch repaved.

The cost of installing the 8-inch pipe lines per foot, complete with valves, hydrants, sleeves, etc., $3.05 per foot.

The cost of installing the 12-inch lines per foot, complete with valves, sleeves, hydrants, etc., $6.00 per foot.

The cost of installing the 16-inch line, per foot, as above, $6.20 per foot.

Attention is called to the contract price per foot for laying the 12-inch pipe (cast iron). It will be noticed it is excessive compared with the 8 and 16-inch mains. The reason for this is due to the fact that the 12-inch pipe lines represent 60 per cent. of the entire service, and in laying this the contractor placed his price per foot to cover the cost and maintenance of paving over the entire system, which paving had to be kept in good order for a period of five years after completion of contract; 80 per cent. Belgian block and 20 per cent. asphalt.

The 20-inch cast iron flanged pumping

main is laid on Water street, from Race street to Market street, and connects with the pumping station at Delaware avenue and Race street.

Total pipe laid, 1,500 feet; total cost, complete, $24.00 per foot. The total cost of installing entire pumping main was $36,000.

—Weights of Pipe.—

8-inch flanged cast iron pipe, 81 lbs. per foot.
12-inch flanged pipe, 161 lbs. per foot.
16-inch flanged pipe, 260 lbs. per foot.
20-inch flanged pipe, 390 lbs. per foot.

The total expenditure for pumping station and pipe system, ready for service, was $750,000, a price we consider as reasonably fair.

As soon as the high pressure system was finished the fire department was taken in hand. A series of tests were given every week, and in making these tests it was found that the old-time method of handling hose nozzles in throwing a stream of water where maximum pressure from the average steam fire engine rarely exceeds 125 pounds, would not answer at all for the new pumping station, with its delivery and pressure maintained at 300 pounds per square inch. Mr. John W. Weaver, my constructing engineer of the high pressure system, designed a water battery capable of taking care of any pressure the station is capable of putting on the pipe lines. Mr. Weaver then turned his attention to the quality of hose, couplings, nozzles used in the fire department, and has made tests lasting through an entire year, on the strength of which a specification on which the fire department equipment has been purchased for this year has been made. Prices were 75 cents per foot for 2 1-2-inch hose, and $1.40 per foot for 3 1-2-inch all cotton rubber lined hose and guaranteed for four years.

Mr. Weaver is the superintendent of the high pressure system, and communications in the future regarding this system will be cheerfully answered by him.

I believe it to be only a question of a few years when the steam fire engine will be abandoned in large municipalities, and central power station system will be in advance. Even in small towns this is absolutely possible and economical with the use of the gas engine working with illuminating gas, gasoline, or by aid of a producer. Of course, a gas engine is not a commercial possibility when operating on illuminating gas at $1.00 per thousand, and running 8 to 10 hours every day. It is, however, possible with the aid of a producer, or natural gas.

There are today numerous small towns throughout the United States that should consider with favor the gas engine proposition with a view towards a combined distribution and fire system, procuring their water supply from artesian well system. Take, for instance, small towns of from 3,000 to 5,000 inhabitants, with the artesian well system. Two gas engines of 50 horse power each attached to pumps could readily and very economically fill a standpipe 125 feet high by 30 feet in diameter, and maintain an efficient supply by operating only 12 hours out of the 24, as is usual with steam plants, and far more economical.

The Philadelphia pumping station, as before stated, was to equal in capacity twenty steam fire engines with a capacity of 10,000 gallons of water per minute. We have done this at a cost of $177,000, and what is better still, we maintain it annually for two thousand dollars less than it costs to maintain one fire company of 12 men.

An Arbitration on the Value of a Waterworks.*

BY ALBERT H. WEHR, SECRETARY AND TREASURER, THE BALTIMORE (MD.) COUNTY WATER AND ELECTRIC CO.

In 1905 there was arbitrated the case of the mayor and city council of Baltimore against the Baltimore County Water and Electric Company. The facts in this case differ from most others in that only a small part of a complete plant was taken by the city, consisting only of certain water mains, business and territory, while the greater part of the territory and pipe system, together with the entire pumping station, reservoir, standpipe, filters, etc, remained unaffected by the taking. It was for this reason that our case presented difficulties not encountered in cases where a complete water works plant is being appraised, and we could, therefore, apply only certain methods of appraisal which have been, from time to time suggested, while others had to be invented to meet the exigencies of our particular case. In order to the better understand the matters and facts to be brought out hereafter, it may be well to devote a few moments to some local history and refer to the statutory provision, as a result of, and under which, this proceeding was had.

In 1886 the Catonsville Water Company was formed for the purpose of supplying water to certain parts of Baltimore county. A plant was built, with its proper pumping station, reservoir, standpipe, filters and system of distributing mains, the latter extending rapidly until a considerable area contiguous to Baltimore city

*From a paper before the American Waterworks Association.

was covered. In 1888 was annexed to Baltimore a territory, in a part of which the Catonsville Water company was operating. For the protection of the water company's interests, there was inserted in the statute by virtue of which this territory was annexed, the following provision, which was later bodily re-enacted in the new Baltimore city charter of 1898:

"Before the city shall lay any water pipes along any street, road, lane or avenue in the territory annexed to the city of Baltimore under the provisions of the Act of 1888, upon which the Catonsville Water company has laid its pipes and other water appliances, the said city shall * * * pay to the said company the fair value of its water pipes and other water appliances, constructed in said street, lane, road or avenue, and such actual damages to the said company as shall be caused by the acquisition of said pipes and appliances by the city; and the amount so to be paid, if the said company and the said company can not agree in reference thereto, shall be ascertained by a majority of a board of three arbitrators, one to be appointed by the city and one by the company, and the two arbitrators thus appointed shall appoint the third arbitrator, and if they can not agree upon such third arbitrator, the latter shall be appointed by the governor of the state."

The Catonsville Water company referred to in this statute was absorbed by the Baltimore County Water and Electric company in 1900.

The city began to move under the provisions of the above statute in 1902, and after considerable preliminary skirmishing on both sides, and the usually attendant litigation, all of which is not essentia* to the subject in hand, it was at last agreed to disagree and to arbitrate the matter. The first question was, who to select as arbitrators. Upon the arbitrators rested the entire question, without appeal. Local sentiment demanded that local men should be chosen, and after carefully looking the field of available men over, it was concluded that the legal profession offered the best material for this special purpose. Following numerous conferences, the city also reached the same conclusion, and the result was that two of Baltimore's leading lawyers were chosen for the respective sides, who in their turn selected the judge of the United States district court for the district of Maryland, as referee.

The statute provided for compensation to the company for two things:

1. The fair value of the pipes and appliances taken.

2. The actual damage sustained by the company by reason of the taking of such pipes and appliances.

The first item presented little difficulty, other than the question of depreciation loss on this property, there being included under this head merely the main pipes and valves, the fire plugs having been installed by and being already owned by the city, and the service pipes having been installed at the expense of, and therefore owned by, the consumers. The second item contained, in addition to several minor points of a strictly local character and therefore of no interest generally, two elements of value for compensation, as follows:

(a) Damage to the company sustained by reason of the loss of present net income.

(b) Damage to the company sustained by reason of the loss of future or prospective net income.

These three elements of value will be treated in the order mentioned.

(1) Fair Value of Water Pipes and Appliances.—This meant the fair present value, or, in other words, the reproduction cost, less depreciation loss, if any. The reproduction cost was a simple matter of computation and was readily determined. That there was a depreciation loss we readily admitted, but we insisted that at best, this item would be very small on the comparatively small quantity of pipes involved, viz.: 5.95 miles of mains, ranging in size from 8-inch down. There was no part of our pipe system more than 20 years old, and some of it had been in the ground less than a year, so that with incomplete records prior to 1900, it was impossible to determine the age of the greater portion of the system.

The city contended that an allowance of 3 1-3 per cent. per year should be made for depreciation, based on a life of 33 1-3 years for the main pipe, but we met this with the proposition which was very clearly stated by Mr. Daniel W. Mead, at the 1902 convention of the American Waterworks association, from which we took the liberty to quote the following:

"Depreciation is often ascertained by assuming a certain length of life for the particular item. For instance, in the case of iron pipes the length of life is often assumed at 100 years, then if the pipe has been in use twenty years, one per cent. is deducted for each year of use. Supposing that the life is correctly assumed, I believe the true representation of the depreciation is the amount, at the date of the estimate, of an annuity or sinking fund, with accumulated interest, which, if set aside annually, beginning at the time the construction is first com-

pleted, will reproduce the value of the pipe at the end of the useful life. Such a fund should, of course, be calculated on the basis of a low rate of interest. For example, if we estimate the sinking fund interest at 3 1-2 per cent., the life at 100 years, and the time expired at twenty years, the amount of the sinking fund at the end of twenty years would be $3.27 on $100.00, or about 3 1-4 per cent. instead of the 20 per cent., as ordinarily estimated."

We had proceeded thus far in our contention when the city admitted our valuation of the pipe system at reproduction cost, without any deduction for depreciation.

(2) Actual Damage Sustained by the Company.—This phase of the question was next taken up, and we proceeded at once to the discussion of the matter of (a) damage to the company sustained by reason of the loss of present net income. At this point we encountered our first serious difficulty. The question was not as to what should be considered as the net income from the part of our plant to be taken, on the theory that this part is a portion of the whole and hence distributing the operating expenses pro-rata to the gross income, but rather and properly, what is the effect of the proposed taking by the city on the portion of the plant which remains to the company, or, in other words, what is left after taking a part. We did not, therefore, consider the part of the plant taken, by itself, but we took the net income as it existed before the taking, and from this deducted the net income as it remained after the taking, and the difference was the amount of net income lost to the company, for which compensation should be made. The following illustration, which states our proposition exactly, has often been used with good effect in cases of condemnations of rights of way through large tracts of land, and may bear repeating here in connection with our case: A has a coat which cost 100 per cent., from which B cuts and appropriates to himself a sleeve. This sleeve in itself is worth only 5 per cent., while the value of the coat, by this operation, is reduced to only 10 per cent. of its original value. In compensating A for the damage done his coat, should he get 5 per cent., the value of the sleeve, or should he get 90 per cent., the difference in the value of the coat before and after the sleeve had been removed. Clearly, he is entitled to the 90 per cent. Apparently B gets the worse end of the bargain, in having to pay 90 per cent. for something which is actually worth only 5 per cent., but we assume that A did not invite the taking of his sleeve, and, therefore, he should not be made to suffer through B's act. And so it was with the city. Our proposition was considered as rather preposterous when we undertook to say that by our method of reasoning, we charged against the 26 per cent. of the gross income within the city and taken by it, only about one per cent. of our operating expenses, contending that the remaining 74 per cent. of gross income would have to bear the remaining 99 per cent. of operation cost. Our contention was presented in the following shape, and actual figures are given in order to state the case accurately:

Gross income, before the taking	$35,803.33
Operating expenses, before the taking	12,245.05
Net income, before the taking	$23,558.28
Gross income, after taking	$26,434.05
Operating expenses, after the taking	12,100.51
Net income, after the taking	$14,333.54
Loss of net income, due to the taking	$9,224.74

To ascertain the gross income before and after the taking was a simple matter, and usually is in every instance, and, therefore, need not be dwelt upon here. The reduction in operating expenses, however, presents a more difficult proposition. We readily determined that the only method of arriving at the reduction, if any, in operating expenses, was by taking up and treating each item of expense separately. Before entering upon this explanation, however, attention must first be brought to the fact that the whole plant involved in this controversy was only one of three separate and distinct plants owned and operated by our company, near Baltimore, and that our business is not alone the supplying of water, but the furnishing of electric current as well. All three of these plants are operated from one central office, and though the part of the plant taken by the city was a substantial part of the particular plant involved in this arbitration, it was a very small part of the entire enterprise.

Our station is operated by water power, although equipped with an auxiliary steam plant, which latter was installed primarily for the electrical end of our business, with provision made, however, for pumping water by steam if occasion requires. We, therefore, did not have the question of reduction in fuel consumption to contend with, and merely showed that the water power cost as much to operate after as before the taking. Our station labor account was not capable of reduction as a result of the

taking, because the mere reduction in water pumpage, under our conditions, did not make possible a reduction in our station force. On the question of station supplies, we showed that on our water wheel driven power pumps, we used no new oil, but only such oil as had been used on our dynamos, and then filtered, and in this way we had always obtained sufficient oil of a quality good enough for the pumps, but not for the high speed dynamos, without having to purchase new oil for this purpose. Our waste was first used on our electrical machinery, after which it was clean enough to be used on our pumps. The pump packing we demonstrated to the satisfaction of the arbitrators, lasted practically as long, whether the pumps operated full time or only partial time. And so on, down the line, we treated each item in this manner, showing that in the matter of station supplies there was no saving to be expected as a result of the taking.

Our station repairs account we also excepted from any saving, on the ground that these items are always uncertain, at best, and though there might be a saving, the item itself was so small, the machinery being all new (the station was built only two years before), the reduction in the work of the station so slight, and the saving, therefore, so insignificant, if anything, that whatever the amount, it should be eliminated from the estimate entirely, as a negligible quantity.

Our reservoir, standpipe and filters maintenance accounts we showed would not be in any way affected, since these properties themselves would not be effected by the taking.

Our filters operation account we estimated would be reduced in proportion to the reduction in pumpage, and this saving we placed at 37 1-2 per cent. of the total annual expense, this percentage representing the estimated reduction in water pumpage due to the taking.

Our street mains, valves and fire hydrants maintenance accounts we estimated would be reduced in proportion to the mileage of mains taken and that left to us, namely, 19.2 per cent.

Our service connections maintenance account we treated in the same manner, 46.5 per cent. of the total services being taken.

The meters maintenance account was also treated in this manner, 17.3 per cent. of the total meters installed being taken.

Our buildings and grounds maintenance account, as also our electric pole lines, wires and equipment accounts, were shown not to be affected by the takling, because these properties were left to us intact.

All our general expense accounts, such as general salaries, office expenses, stationery and printing, taxes on county property (Baltimore city and Baltimore county being two entirely separate and distinct municipalities, independent of each other), insurance, stable and miscellaneous, were treated in detail and shown not to be affected by the taking, there could be no reduction in these items.

We thus proved that the total saving in operation would amount to only $144.54, or 1.1 per cent. of the whole, and when we were through, the proposition did not seem so very unreasonable.

The rate per cent. at which the loss of net income should be capitalized, was variously placed by the several witnesses at from three to four per cent. It was conceded that, whatever compensation the arbitrators would fix, the amount thus received would have to be invested in a sinking fund for the redemption of outstanding bonds of the company, and the capitalization should, therefore, be upon a rate at which the principal sum could be safely invested for this purpose. The question as to what would be a safe investment for this purpose, and the rate to be obtained from such an investment was largely a matter of opinion, hence the difference in views.

We come now to the last element of damage, namely:

(b) Damage to the Company Sustained by Reason of the Loss of Future or Prospective Net Income.—This element of value for which compensation should be made represents the valuation of our franchise, over and above its present earning capacity; the good will, or the going value, call it what you may.

Our franchise was perpetual, so far as it could be made perpetual under the constitution of Maryland, and in the territory taken over by the city, it was, because of local conditions, to all intents and purposes, exclusive. In fixing the value of the franchise, we contended that both these considerations were entitled to their just weight. We contended that our plant was a going and a growing concern; that the value of its franchise depended upon its earning power, present and prospective, developed and capable of development; that the valuation put upon it must be its value to the seller and not to the buyer; that future profits must, of necessity, enter into any arrangement which has for its object the sale of a franchise; and that a franchise has no special value, except insomuch as it confers future benefits on its holder.

The future or prospective profits are capable of reasonably accurate ascertainment, we undertook to show in the following manner: We prepared and

submitted plats of the territory in question, on which we had sub-divided all vacant land in our territory into lots of the same average size as those already improved or built upon. Next we determined how fast these vacant lots would be improved, assuming as our basis that the development in our territory would continue at the same rate as in the past. By taking the average growth during the entire period in which we had operated in the territory in question, as well as for the past five eyars, the two results being about equal, as a guide, we concluded that this territory should, under normal conditions, be entirely built up in 68 years. Taking the average growth for each year of this period and applying to the number of buildings the average income per tap at present earned, we ascertained the amount of annual income increment, and the total income at the end of the 68th year. By a compound interest calculation, the present worth or value of the income at the end of the 68th year, as well as the present worth of the annual increments during the running of the 68 years, was determined.

Mr. Hill, by a similar method, ascertained that 73 years would be the length of time in which the territory would be fully improved, and based his calculation on this period of time. By a second method, he averaged the net future increments of income and capitalized this average amount as present income; and by a third method, he ascertained from the records of the Baltimore city water department the increase in water consumption for a number of years back, and assuming that the growth in population and in water consumption follow each other in a fixed ratio, he calculated that applying this same rate of growth to our territory, it would be fully improved in from 35 to 50 years, and from this made his calculation of present worth.

Mr. Allen arrived at the future prospective profits by entirely different methods, his first two methods probably being more easy of application to the average case than any others suggested. First he took the average income per mile of pipe from several works with which he was personally familiar, and applied this average to the mains still to be laid, and those already laid, in order to cover the undeveloped portion of our territory, and assuming that it would require a period of fifty years to accumulate this total prospective income, he readily reduced the figure thus obtained to present worth, by a compound discount calculation. Second he took the average income earned by our plant per mile of pipe, already laid in our territory, and applied this income to the mains still to be laid in order to cover the entire field, and by the same calculation, reduced this to present worth. These two methods demonstrated that our plant was within the limits of averages from other plants, and that, therefore, the results obtained with other plants might very properly be expected from our property. His third method was a departure from the preceding two in that here his calculations were based entirely upon the growth of population in our territory. This growth of population for the past 18 years, the limit of time for which this information could be obtained, he represented on a chart by a line, and from this line he projected a curve, from which the prospective increase in population at intervals of five years each, and for fifty years in the future, could readily be calculated. To this increase in population, he applied the present income per inhabitant, and having thus obtained the annual increment in income due to growth of population, he readily reduced this to present worth by his compound discount calculation.

It must be apparent from the foregoing that there was a wide difference between the values placed on the franchise, over and above its present earning capacity, by the several methods mentioned, though the results were relatively interesting, but it was shown that any of the methods of valuation might be adopted as the correct one and applied with fairness and justice to both sides.

The contentions of the city of Baltimore were briefly these:

That our theory as to the effect of the taking on our operating expenses was erroneous, but as a matter of right and justice, assuming, for the sake of argument, that the effect, contended for by the company, would actually occur, even then the city should not be made to suffer, because of the peculiarities of our plant, and our conditions of operation, to both of which is attributable our inability to cut down expenses, after the taking, in proportion to the reduction in income.

That a capitalization of net income could not be made in order to determine the value of this income, because the amount sought to be capitalized is uncertain, and subject to fluctuation from many causes, and that, therefore, the amount thus obtained should be treated merely as an index to value, and not as the value itself.

That the provisions of the city charter, under which the proceeding was had, intended to protect our company merely against present actual damage or loss, and not for any losses, real or imag-

linary, which might be sustained in the future, and on this point it relied entirely upon the legal aspect of the question.

The award as fixed by the arbitrators was $230,618. The amount equaled a capitalization at 4 per cent. of our loss of present net income. In their award the arbitrators gave no reasons or specific details explaining the manner of arriving at their conclusions, but the following inferences can very fairly and properly be drawn from the result:

That the value of the physical property is included in the capitalization of net income, and should not be separately and additionally allowed.

That a 4 per cent. capitalization of net income is a fair compensation for the taking of this income, in view of the fact that the bonded debt of the company bears interest at the rate of 5 per cent.

That the provisions of the city charter under which the proceeding was had were not sufficiently broad to allow compensation for loss of franchise value over and above its present earning capacity.

Comparative Efficiency of Cast Iron and Riveted Pipe.*

BY L. J. LE CONTE, SAN FRANCISCO, CAL.

Experience at and near San Francisco, Cal., has been particularly valuable in developing the relative value of these two classes of pipe. In the earlier days, say in 1867 and 1868, it was very hard to get cast-iron pipe at any price and as a result necessity compelled the old pioneer engineers to make riveted pipe. Later on these pipes were coated inside with Rosendale cement lining, which in places added much to the life of the pipe. As the city of San Francisco increased in population the unavoidable loss of water, due to leakage in the distributing system, soon became unbearable. Steps were at once taken to replace the city pipes with cast-iron as fast as possible. This very soon brought the consumption per capita down to the present rate, about 70 gallons per head per day for a population of 500,000, which agrees pretty well with eastern experience.

Across the bay at Oakland, Cal., population 100,000, there seems to have been a lack of foresight in this direction, and although cast-iron pipe are being slowly introduced in the distributing system in place of the old pioneer riveted pipes, yet the fact remains that they still have some 76 miles of the old riveted pipes in service, and as a result we have the enormous per capita consumption of 180 gallons per day, which can best be explained by inordinate leakage in the distributing system.

The natural life of riveted pipe well coated and carefully laid in average soil may be safely placed at 40 years. This refers to good wrought-iron riveted pipe, of which we have good record. Experience with steel pipe is more limited.

The natural life of cast-iron pipe, well coated and carefully laid in average soil, may be safely placed at 75 or 80 years.

Experience everywhere seems to show conclusively that riveted pipe is par excellence the best and cheapest for all ordinary pipe lines and for supply mains leading from the intake to the city limits. After entering the city boundaries the only pipe which will always give general satisfaction is cast-iron. The principal reason for this being not so much the increased life of the pipe as the far better facilities they naturally offer for making good tight taps, which will not leak. This is the weak point with all riveted pipe, cement lined and Converse pipe. The metal is too thin and you cannot make a good efficient tap and, moreover, the leakage from these taps grows worse and worse with increased pressure and age. The introduction of meters of course can not affect this loss.

A new element has come into the field of late years, namely, electrolysis, which is growing to be quite serious. The manifestations so far are chiefly at and near the power stations where the return current leaves the pipes. We are slowly gaining experience in this direction, but up to the present time cast-iron pipe seems to stand the new enemy much better than the other class of pipes.

Steel vs. Wrought-Iron for Riveted Pipe.—Much controversy has arisen of late years in regard to which of these is the better for riveted pipe. All of the older and more experienced engineers cling to wrought-iron as the best pipe, and base their opinion on old existing pipelines, which, of course, is hard to refute. On the other hand, the steel men, who are rapidly gaining control of the entire market, maintain that it has not yet been proved by a single case on fair trial, which may also be true. There seems to be little doubt about the fact, however, that the average steel used for pipe is a heterogenous mixture of high-grade, medium, and low-grade, all milled up together in one sheet.

It is maintained, with some force, that this inequality in the character of the metal must surely bring about internal galvanic action, which will very materially increase the annual rate of degree of

*From a paper before the American Waterworks Association.

rusting. This, of course, shortens the life of the pipe somewhat. Future experience alone will settle this question. As steel is now practically monopolizing the market to the complete exclusion of wrought-iron, this open question may never come up again. That is to say, the cheapness of steel pipe will undoubtedly drive wrought-iron pipe out of the market, in spite of its slight superiority. Should the steel men be more careful about maintaining one grade of steel in manufacturing plates then this superiority would vanish.

Expanding Water Supply Systems.*

BY J. T. FANNING, C. E., MINNEAPOLIS, MINN.

A thriving young city is surely destined to be in time perplexed with complaints that the water pressure in its distribution mains is insufficient, notwithstanding the quantity of water at its source may be ample. Such complaints come sooner if the city grows fast, and also if the locality is undulating, so that fine residences are built upon suburban hills that are fifty to one hundred efet higher than the business section. Such complaint comes sooner if the source, or pumping station, is far to one side of the city, or if tram lines encourage the building up of suburban groups of residences or manufacturing centers far to one side of the city and opposite to the site of the pumping station or reservoir.

Where there are direct pressure systems of pumping for fire services the lack of water pressure at times of large draft of water is often erroneously attributed to a weakness of the pumps, while the officials know that the pumps are in good order and give, when required, full one hundred pounds per square inch water pressure at the station when a fire is in progress. Sometimes the citizens suspect that the pipes are filled with sediments, or with algae or with tubercles so that the water cannot flow in sufficient quantity to give the desired pressure. As cities grow the pipes are extended, and the draft of water increases, but rarely do more than parts of the city councils recognize that *lengths* of the main and distribution pipes and increased *velocities* of flow have both important effects in the losses of pressure.

Work must be done, either by pump pressure or by gravity head, to press water through a pipe with rapid flow, as when there is a draft for fires. The work done to give velocity of flow of water in such case in a straight pipe is in proportion to the square of the velocity of flow, so that if the rate of flow is doubled in a given pipe the work is quadrupled. Also if the length of the given pipe is increased the work done to press the given quantity of water forward is increased in proportion as the length of the pipe is increased, and this work is being done in increments all along the length of the pipe. The total of this work is the product of the pressure into the given rate of motion of the flowing water, and in such case is called friction of flow, and may be expressed in the equivalent of feet head, or pounds per square inch, as, for instance, if a pump has to press water through one mile of 12-inch pipe lying level with the pump at the rate of one million gallons per 24 hours, then the initial pressure must be equivalent to 7.13 feet head, and if the rate of flow is increased to two million gallons per day then the initial pressure must be increased to an equivalent of 28.5 feet head, the initial pressure varying with the square of the rate of motion.

Then, if the same pipe is increased to two miles length the work or pressure in feet head for a given flow will be doubled, and if to four miles length the work or pressure will be quadrupled.

In usual practice the cause of complaint appears in a different form, for when a fire is in progress the pressure is maintained constant at the pump house, thus, if the pressure at the pump house is 100 pounds per square inch, or equivalent 231 feet head, then in the four miles of twelve-inch pipe above, the reduction of pressure at the discharge end of the pipe would be 28.52 feet of head when the flow was at the rate of one million gallons per day and 114 feet of head when the flow was at the rate of 2 million gallons per day.

These are elementary statements and familiar to water works officials, but they are not familiar to citizens or city councils generally, and the water department officials ought to impress them upon the citizens by many repetitions, for it is the citizens who must provide the cash to remedy such causes of their own complaints.

Such losses of pressure in distribution pipes, when there is a strong flow in one direction only, may be clearly presented in tabular form for a moderate number of conditions that are not unusual, and the consideration of them may be simplified by first taking cases showing losses due to flow for fire streams alone.

*From a paper before the American Water Works Association.

FRICTION HEAD LOSSES IN PIPES.

When 1⅛-inch Hose Nozzles are Used.

No. of 1⅛-inch Fire Streams.	Rate of Discharge in Mil. Gals. per 24 hours.	Diameter of Main Pipe. Flow in one direction.	Friction loss of head per 1,000 feet of pipe.	Friction loss of head per mile of pipe.
1 Stream.	½ Mil.	6-inch.	5.3 ft.	27.98 ft.
1	½	8	5.0	26.40
1	½	10	1.7	8.97
3	1	8	10.6	55.97
3	1	10	3.6	19.00
3	1	12	1.36	7.18
4	1½	10	6.1	32.21
4	1½	12	2.4	12.67
4	1½	14	1.1	5.81
6	2	10	13.4	70.75
6	2	12	5.35	28.25
6	2	14	2.5	13.20
6	2	16	1.22	6.44
9	3	12	11.6	61.25
9	3	14	5.38	28.40
9	3	16	2.73	14.41
9	3	18	1.56	8.24

FRICTION HEAD LOSSES IN PIPES.

When 1¼-inch Hose Nozzles are Used.

No. of 1¼-inch Fire Streams.	Rate of Discharge in Mil. Gals. per 24 hours.	Diameter of Main Pipe. Flow in one direction.	Friction loss of head per 1,000 feet of pipe.	Friction loss of head per mile of pipe.
1 Stream.	½ Mil.	6-inch.	13.1 ft.	69.17 ft.
2	1	8	10.65	56.23
2	1	10	3.56	18.80
2	1	12	1.36	7.18
2	1	14	.65	3.43
4	2	10	13.4	70.75
4	2	12	5.35	28.28
4	2	14	2.5	13.20
4	2	16	1.22	6.44
6	2½	12	8.2	43.30
6	2½	14	3.8	20.06
6	2½	16	1.9	10.03
6	2½	18	1.1	5.81
8	4	14	9.3	49.10
8	4	16	4.75	25.08
8	4	18	2.7	14.26
8	4	20	1.5	7.92
10	5	14	14.3	75.50
10	5	16	7.33	38.70
10	5	18	3.95	20.86
10	5	20	2.33	12.30
10	5	24	0.95	5.02

The tabled volumes of flow and friction losses are, of course, enhanced by the added domestic flows. In small cities the proportion of the supply pipe required for the domestic flow seems insignificant as compared with the proportion required for fire extinguishment flow, but as cities grow the domestic flow percentage increases, while the fire flow percentage decreases.

In considering the combined rates of flow in distribution pipes, for both domestic and fire purposes, it will be interesting to note the relative proportions of the pipe capacities required for the domestic and fire purposes, in the same city, as it grows, or in different cities with different populations.

COMBINED DOMESTIC AND FIRE FLOWS.

Population	5,000	10,000	25,000	50,000	100,000
Average gallons, per person, daily	60	65	70	80	90
Domestic rate, daily, mill. gals.	0.30	0.65	1.75	4	9
No. of good 1⅛-in. fire streams	8	10	12		
No. of good 1¼-in. fire streams				14	16
Fire rate, mill. gals.	2.67	3.33	4	7	8
Combined domestic & fire rates, mill. gals.	3	4	5.75	11	17
Min. diam. of single main, inches, for single flow	14	16	18	24	27

The table indicates the portion of the supply main required for the domestic flow at the times when there is also a fire flow, and for different populations, is as follows: For 5,000 population, 10 per cent.; for 10,000 population, 16.25 per cent.; for 25,000 population, 30.43 per cent.; for 50,000 population, 36.36 per cent., and for 100,000 population, 52.64

per cent.* In larger cities the domestic flow requires one-half and more of the supply main capacity of the combined flow. The cost of the fire service capacity in the water mains is relatively greater in the small than in the large cities, and relatively greater in the suburban than in the urban streets.

If the supply main continues of the same diameter or is not reinforced as the domestic rate of flow increases, then it must be remembered that the pressure losses vary more rapidly than the flow rate increases, for if by increase of domestic consumption the total flow is increased fifty per cent. the friction loss is increased as the square of 1 to the square of 1.5, or 125 per cent.

Friction losses of pressure are more excessive in fire hose than in the pipes, because, owing to the small diameter of the hose, the velocity of flow is great.

A 1⅛-inch smooth hose nozzle, having a water pressure at the nozzle of 40 pounds per square inch, will deliver approximately 231.5 gallons of water per minute, or at a rate of one-third million gallons per day.

A 1¼-inch smooth hose nozzle, having a water pressure at the nozzle of 55 pounds per square inch, will deliver approximately 347.2 gallons of water per minute, or at a rate of ½ million gallons daily.

The friction losses of head in each 100 feet of 2½-inch smooth hose when delivering the above quantities of water is indicated by the following table when the friction loss, h, in the hose is computed by the formula:

When the citizens clearly understand the true causes for their complaints they will usually provide funds for the remedy to the extent of their financial ability, whether the complaints are as to inefficiency or to impure quality of the water supply.

When the pipe system has expanded to an undue overgrowth a new capacious reinforcing main, passing through and connected with the branch pipes of a former main, and carrying a free flow and strong pressure of water toward the extremities of the system, is a first remedy demanded. Such duplicate main will not only improve the efficiency of the flow and pressures, but will add greatly to the protection of the city by providing a second line of supply in case of injury to the first line, and will provide many facilities for such better operation and care of the system as the superintendent well understands.

When the buildings are three or more stories in height there should be two hydrants at each street intersection, and where the city blocks in business sections exceed 450 feet in length there should be a hydrant near the middle of the block.

The great loss of pressure in each one hundred feet of hose, above shown, emphasizes the fact that hose lengths should not exceed 250 feet, unless the hose lines are doubled, and therefore that fire hydrants should not be widely separated. Good hydrants are not expensive in maintenance, while hose is short-lived in its full strength. Hydrants are cheaper in the long run than hose, and are much less liable to fail at a critical time.

For head, $h = \frac{lq^2}{1800d^5}$ or for pressure, $p = \frac{lq^2}{4157d^5}$ in which d = diameter of hose, in inches, l = 100 feet, q = gallons per minute, h = friction head lost, in feet, and p = lbs. per square inch.

	Pressure at Nozzle.	Gallons per minute.	Friction head per 100 ft. of 2½-in. hose.
1⅛-inch Hose Nozzle	40 lbs.	231.5 gals.	30.48 ft. = 13.19 lbs.
1¼-inch Hose Nozzle	55 lbs.	347.2 gals.	68.57 ft. = 29.69 lbs.

The friction losses in the long distribution pipes lead to inadequate pressure for domestic service on the high grounds, and in high buildings. The friction losses in the long pipes and in the long hose lead to loss of height or distance to which fire streams can be thrown, or to a dimunition of the quantity of water discharged by each fire stream, and usually to both loss of volume of water discharged and strength of stream, until the streams are inefficient for fire protection, especially when the hose lengths are considerable. Therefore, there is just cause of complaint, and complaints are frequent.

The above tabled losses of pressure apply to flows in one direction in a single pipe.

The flow of water toward a hydrant should be from two directions and to distant parts of the system through duplicate mains, so that the velocity of flow may be halved and the loss of pressure due to flow reduced to one-fourth that of an equal quantity of single flow. The disposition of the large distribution pipes, to be added as the pipe system expands, should be in accordance with a reinforcing system so as to conserve the pressure at all points, and give a duplicate flow to all points, and thus give the best serv-

*The percentages given have been recomputed by the editor.

ice at all points for both domestic and fire purposes.

The maintenance of each water supply system in the highest state of efficiency is of such supreme importance that the citizens should be constantly taught that the city best prepared to promptly and effectively fight a fire at its inception is the city having the greatest probability of sparing the awful penalties of a great conflagration.

There Was a Sewer Pipe Trust.

In behalf of the allied companies of the Sewer Pipe Trust, Harry Alvin Hall, of Pittsburg, promised that the combination should be dissolved, rather than submit to the investigation of the Federal grand jury, in session at Jamestown, N. Y. The organization is known to the public as the Sewer Pipe Trade Association; to the trade as the Sewer Pipe Trust. Mr. Hall's promise was accepted and investigation of business methods of this combination was abandoned. According to the articles of agreement in possession of the government, the Sewer Pipe Trade Association was composed of the following companies:

American Sewer Pipe Company, Pittsburg; Buckeye Sewer Pipe Company, Akron, O.; Clearmont Sewer Pipe Company, Clearmont, Penn.; Duquesne Fire Proofing Company, Pittsburg; East Ohio Sewer Pipe Company, Irondale, O.; Federal Clay Manufacturing Company, New York; James Loeb Company, Uhrichsville, O.; New York Sewer Pipe Company, Rochester; Patton Clay Manufacturing Company, Patton, Penn.; Pittsburg-Buffalo Company, White Rock, Penn.; Portland Stoneware Company, Portland, Me.; Robinson Clay Product Company, Akron, O.; Robinson Graves Company, Uhrichsville, O.; Shawmut Clay Manufacturing Company, Uhrichsville, O.; St. Marys Sewer Pipe Company, St. Marys, Penn.; Kane Aberkersch Company, Toronto, O., and Stratton Fire Clay Company, Empire, O.

The grand jury has adjourned until August 6.

ORGANIZATIONS AND INDIVIDUALS

American Society of Civil Engineers—Block Machine Makers—Waterworks Association—Civic Association—Society of Municipal Improvements—Technical Meetings—Civil Service Examinations—Asphalt Trust—Personal Notes.

Convention of American Society of Civil Engineers.

The thirty-eighth annual convention of the American Society of Civil Engineers was held at the Frontenac Hotel in the Thousand Islands, June 26, 27, 28 and 29. The report of the committee on a proposed amendment to the constitution, involving almost entirely the subject of qualifications for membership in the society, brought out a lively discussion. A committee was appointed at the annual meeting of the society in January, 1896, with instructions to submit at the following annual convention any amendments to the present provisions governing these questions which the committee might recommend. The proposed changes were brought about by an almost universal desire among the members that the standard of qualifications for the various grades of membership be raised, and that, if feasible, the titles of classification at least should be changed in such a way that the different grades might have more complete distinction. A set of amendments submitted by the committee was read and discussed at the present convention, and aside from minor changes, the principal requirements proposed are:

(1) Raising the age limit for full membership from 30 to 33; (2) requiring that candidates for member must have attained "a recognized position of honorable high standing in the profession;" and (3) dropping the grade of Fellow.

An extra session was called on the evening of June 27 to discuss these amendments, with the result that the amendments were referred back to the

committee for revision in accordance with numerous criticisms and suggestions made at the convention, their revised form to be submitted to the membership at large some time previous to the next annual meeting, when they will come up for final action.

Prof. G. F. Swain, of Boston, Mass., opened a topical discussion on "Engineering Education" with two short papers, respectively, "What is the Best Preparatory Education for the Civil Engineering Profession?" and "Is Technical Training the Best Education for Executive Work?" G. C. Whipple submitted a paper entitled "The Advance in Sewage Disposal," in which he divided sewage treatment into three parts, namely: (1) Preparatory Processes; (2) Purification Processes; (3) Finishing Processes. "What are the Best Means for the Prevention of Conflagrations in Large Cities?" was the title of a paper presented by J. R. Freeman, of Providence, R. I.

Block Machine Makers' Convention.

A meeting of the Concrete Block Machine Manufacturers' Association will be held at the Wayne Hotel, in Detroit. August 8 and 9.

On the morning of the 8th officers and committees will report, and in the evening a banquet will be held at the hotel. On Wednesday afternoon and Thursday morning and afternoon, the following papers will be read and discussed:

"Sales of Concrete Block Machines, the Uses of Its Product, and the Industry in General," by O. U. Miracle, Miracle Pressed Stone Co., Minneapolis, Minn.

"Freight Classifications for Concrete Machinery," by J. F. Angell. Winget Concrete Machine Co., Columbus. O.

"Concrete Block Insurance," by Sid L. Wiltse. Cement Machinery Co., Jackson, Mich.

"Specifications for Concrete Blocks and Brick," by Frank L. Dykema, The Dykema Co., Grand Rapids, Mich.

"Special Demonstration of Medusa Compound," R. R. Fish. Sandusky Portland Cement Co., Sandusky. O.

"What the Government is Doing for Concrete Blocks," by Richard L. Humphrey, Engineer and President N. A. C. U., Philadelphia, Pa.

"Foreign Trade," by M. Wetzstein. Ideal Concrete Machinery Co., South Bend, Ind.

"Concrete Block Architecture," by A. T. Bradley, Century Cement Machine Co., Rochester, N. Y.

"Ornamental Products," by E. G. Harter, Cement Working Machinery Co., Detroit, Mich.

"Advertising," by S. J. Young. P. B. Miles Mfg. Co., Jackson, Mich.

"Cast Stone," by C. W. Stevens, Harvey. Ill.

"Coloring of Concrete Products," by J. P. Sherer, Nat'l Bldg. Block Co., Milwaukee, Wis.

"Concrete Blocks and Brick from an Insurance Inspector's View," by W. G. Sanderson, Inspector and Member Committee on Cement for Building Construction of National Fire Protection Association. Chicago, Ill.

"Out West," by J. W. Sanderson, Cement Machinery Mfg. Co., Burlington, Ia.

"Trade Journal Advertising and General Publicity," open to short talks by various representatives present.

"The Industry," by W. J. Scoutt, American Hydraulic Stone Co., Denver, Colo.

"Plastering and Lathing to Concrete Blocks," by John G. Miller, Winner Block Machine Co., Minneapolis, Minn.

"Great and Universal Use of Concrete Blocks and Brick," discussed by all members present.

American Waterworks Association.

The twenty-sixth annual convention of the American Waterworks Association was held at Boston, Mass., July 10, 11, 12, 13 and 14. Reports of the various committees were submitted. Mr. Dabney H. Maury, chairman of the committee on electrolysis, reported there had been no encouraging change or developments during the last year that warranted changing the previous recommendations of the committee. The law suits pending a year ago are all in statu quo and the injury to pipes still going on. The committee on waterworks standards submitted to the association, through its chairman. Charles A. Hague, of New York. a form of specifications for cast iron pipe, and reported that some progress had been made during the last year in the direction of promulgating and enforcing feasible waterworks standards.

Some of the papers submitted at the meeting were the following: "Method of Filtration Used by the Indianapolis Water Company," F. A. W. Davis; "Notes on Sewage Disposal and Public Water Supplies," M. N. Baker; "River Pollution," M. O. Leighton; "The Greatest Typhoid Epidemics," George A. Soper; "Water Softening for Municipal Plants," George W. Fuller. Wednesday afternoon was devoted to papers and discussions bearing on the Chicago drainage canal case, as follows: "A Symposium on the Chicago Drainage Canal Case." Prof. W. P. Mason; "The Chicago Drainage Canal in the United States Courts," John W. Hill; "Self-Purification of the Mississippi

River During the Latter Part of Its Course." Robert Spurr Weston; "Abstract of Testimony," Prof. T. J. Burrill, Prof. Gardner S. Williams, Prof. E. O. Jordan, Prof. H. L. Russell. Messrs. Rudolph Hering, George W. Fuller, Allen Hazen, George C. Whipple, Prof. Leonard C. Kinnicutt, Elbert E. Lochridge.

On Thursday morning Prof. James M. Caird, of Troy, N. Y. read a paper on "Copper Sulphate Results." which was followed by a paper on "Disinfection as a Means of Water Purification," by Geo. C. Whipple. Other papers presented were as follows: "Expanding Water Supply System," J. T. Fanning; "The Growth of the Pumping Station," Chas. A. Hague. Abstracts of several of these papers will be found in this and subsequent numbers of MUNICIPAL ENGINEERING.

Officers for the ensuing year were elected as follows: President, Dabney H. Maury, Peoria, Ill.; vice-presidents, Geo. H. Felix, Reading, Pa.; John B. Heim, Madison, Wis.; Alex. Milne, St. Catherines, Ont.; D. W. French, Hoboken, N. J.; Prof. W. P. Mason, Troy, N. Y. Mr. John M. Diven, of Charleston, S. C., was unanimously re-elected secretary-treasurer. Toronto, Ont., will be the next meeting place.

American Civic Association.

This year's convention of the American Civic Association will be held in Milwaukee.

The first morning session will be devoted to the addresses of welcome, the annual review of the secretary, report of the treasurer, the nomination and election of officers and miscellaneous business.

Wednesday afternoon the association's work for the year will be covered in ten minute reports from each of the departments, which are as follows: Women's Outdoor League; Arts and Crafts; Children's Gardens; City Making; Libraries; Outdoor Art; Parks and Public Reservations; Railroad Improvement; Rural Improvement; School Extension; Social Settlements.

Other features of the Wednesday afternoon session will be papers and addresses on "Wisconsin's Contributions to Civic Progress." Special attention will be devoted to the work in Milwaukee, Madison, Racine and Menomonee, and also to the traveling library system of the state.

Thursday morning there will be papers on "San Francisco's Opportunity and How She is Using It," by ex-Mayor James D. Phelan, vice-president of the association, and David H. Burnham, who furnished plans for the rebuilding of the Golden Gate city. The program on Thursday morning will also cover addresses on "Architecture and Civic Progress."

Thursday afternoon will be devoted to "What Women are Doing for Civic Improvement," under the general direction of Mrs. Edward L. Upton, chairman of the Women's Outdoor Art League department of the association. Arrangements have been made already for papers by Mrs. William Christian, of Texas; Mrs. M. F. Johnson, of Indiana, and Mrs. C. B. Crane, of Michigan. Additional speakers will be engaged before the convention meets.

The greatest general interest in the convention will doubtless center around the Thursday evening session, and its discussion of national civic problems. J. Horace McFarland, president of the association, will speak on "The Niagara Campaign." Hon. Henry B. F. Macfarland, one of the commissioners of the District of Columbia, will discuss "Our National Capital." "The Appalachian Reservations" will be the subject of addresses by Henry A. Barker, Gifford Pinchot and J. T. Rothrock.

Thursday morning there will be special discussion of "The Civic Opportunity in the South" and papers as follows: "A Western View of the Problem," by Erasmus Brainerd, Washington; "What One Man Did," by W. A. Finklenburg, Minnesota; "What One Association Did," by F. A. Whiting, Massachusetts; "Mosquito Extermination," by General F. D. Grant, United States army.

The American Society of Municipa Improvements.

It is a little early for the busy members of the American Society of Municipal Improvements to announce the subjects of their papers, but several have been received and word from the chairmen of committees indicates that they will sustain the reputation of the society for good programs. Mr. James Owen, chairman of the committee on paving; J. N. Hazlehurst, chairman of the committee on sewerage and sanitation; Julian Griggs, chairman of the committee on waterworks and water supply; William S. Crandall, chairman of the committee on taxation and assessment; T. C. Hatton, chairman of the committee on disposal of garbage and street cleaning; L. G. Weisleder, chairman of the committee on municipal franchises; A. Prescott Folwell, chairman of the committee on review, and G. A. Parker, chairman of the committee on park development and maintenance, have reported progress in their committee reports and in the procuring of papers. Mr. Griggs will

present a paper on "The Cost of Clearing and Grubbing a Reservoir Site," and Mr. Taubenheim, a member of the waterworks committee, will present a paper on "The Waterworks at Archangel, Russia. Several good papers are promised from the south, and Birmingham will be fully represented on the program.

The next convention will be held on the second Wednesday in October, in Birmingham, Ala. The local arrangements are in the hands of Julian Kendrick, city engineer, and John M. McCartin, street commissioner, who will doubtless sustain their own and the city's reputation for hospitality.

The committee on exhibits has organized for work, and under the guidance of Mr. Wood promises an exhibit equal if not superior to that made at Montreal. There is plenty of room in a good building for all the exhibitors who may come, and it is in proper location with reference to the convention hall to secure the best results for both.

Birmingham is a city which can point to expenditures for public improvements under its present charter amounting to $1,612,502. of which about $300,000 was completed in 1905, and $150,000 was put under contract and not completed during that year. The work of the present year iis similar in amount. The water supply system, including the filter plant, the sewer system and the pavements are modern and comparatively new and are well worth close study by municipal officials, who will have specially favorable opportunities to inspect them at the time of the convention. Birmingham and its vicinity is famous for its manufacturing industries and these add to the interest of a visit. October is the ideal month for a trip to the south.

Technical Meetings.

The annual convention of the International Association of Municipal Electricians will be held at New Haven, Conn., August 15, 16 and 17. Frank P. Foster, secretary, Corning, N. Y.

The annual convention of the League of American Municipalities will be held at Chicago, Ill., Sept. 26, 27 and 28. John McVicar, secretary, Des Moines, Ia.

The convention of the Wisconsin League of Municipalities will be held at Ashland, Wis., Aug. 22 to 24.

The fourth congress of the International Association for Testing Materials will be held at Brussels, Belgium, Sept. 2 to 8.

The thirty-second annual convention of the International Association of Fire Engineers will be held at Dallas, Tex., Oct. 9, 10, 11 and 12.

The International Association of Municipal Electricians will meet at New Haven, Conn., Aug. 15-17. Among the papers to be presented are the following:

"History of the Fire and Police Telegraph." by Adam Bosch, Newark, N. J.

"Details of Certain Auxiliaries to Fire Alarm Apparatus," by J. B. Yeakle, Baltimore, Md.

"Advisability of Protecting Municipal Electricians by the Civil Service Laws." by Jerry Murphy, Cleveland, O.

"Comparison of the Underground and Overhead Wiring, and of the Relative Values of Single, Rubber-Covered Wire and Lead Incased Cable for Underground Construction," by W. H. Thompson, Richmond, Va.

"Conditions Surrounding the Inspection of Wires in the Southwest (with special reference to the advisability of one inspector completing each inspection, instead of several inspectors doing a part of it)", by Clarence R. George, Houston, Texas.

"Question Box," by Walter M. Petty, Rutherford, N. J.

Civil Service Examinations.

The United States Civil Service Commission will hold examinations at the usual places, as follows:

Aug. 8 and 9 for surveyor in the Philippine service, at $1,400 a year, there being at least 18 vacancies at the present time ,and 40 new places contemplated in the near future.

Aug. 29 and 30. For at least 10 vacancies at assistant engineer in the Philippine service at salaries of $1,400 to $1,600, and two or more at $1,800 each.

Asphalt Trust Scandal

The inside workings of the big asphalt trust, especially the details connected with the financing of a revolution by it, in Venezuela may be brought to light by a suit which has been instituted in the supreme court of New York by A. L. Barber against the voting trustees of the General Asphalt Co. for $100,000. which is based upon alleged libelous statements in the report of President Mack, of that company, to the trustees. Barber was charged in the report with misappropriating over half a million of dollars of the trust's money and also that while president of one of the subsidiary companies of the trust he undertook to develop a rival asphalt company in Mexico. It was also charged in Mack's report, that said Barber entered into a conspiracy with President Castro, of Venezuela, to rob the trust of the Bermudez lake, a principal source of asphalt supply and

then, after Castro's government had seized and held the lake, that Barber undertook to sell it back to the trust. It will be remembered that it was in connection with this matter that representatives of the trust acknowledged that they had financed a revolution in Venezuela to the amount of $130,000.

Personal Notes.

F. L. Osmer has been appointed city engineer at Aberdeen, Wash.

C. A. French has succeeded F. G. Berry as city engineer at Laconia, N. H.

Dabney H. Maury, Peoria, Ill., was elected president of the American Water Works Association, at Boston.

Charles O. McComb has been appointed resident engineer in charge of the State road work in the vicinity of Utica, N. Y.

John W. McKay has been appointed acting chief engineer of the department of water supply, gas and electricity of the borough of Brooklyn, New York City.

Winthrop W. Ruggles, formerly chief engineer of the street and water department of Jersey City, N. J., died at his home in that city, June 30, aged 74 years.

James Donahue, Kansas City, Mo., has resigned as secretary of the National Board of Trade to accept the position of traffic manager of the Kansas City Portland Cement Company.

Olaf Sangstad has established offices at 13 Park Row, New York City, where he will practice as consulting and designing engineer. He will make a specialty of temperature and pressure regulation.

Edward Hawes, Jr., of Florence, S. C., has been elected city engineer of Orangeburg, S. C. Mr. Hawes has been associated with Frederic Marshall, consulting and contracting engineer, of Abbeville, S. C.

C. E. Gregory, recently with the sewer department of the Borough of the Bronx, New York city, has accepted the position of designing engineer for the Board of Water Supply of the city of New York, with offices at 299 Broadway.

A. D. Flinn, department engineer of the Board of Water Supply of New York City, left for a trip through the Southwest and West, July 18, to visit the principal projects that have been completed or are under construction by the United States Reclamation Service.

Messrs. Rudolph C. Becker, Robert J. O'Meara, Harry E. Hollingsworth and Harry B. Thorn have been appointed assistant engineers to the Board of Water Supply of New York City. Llewellyn Lewis has been appointed superintendent of underground surveys of that board.

George Y. Wisner, consulting engineer, died at his home in Detroit, Mich., July 3, of stomach trouble, aged 65 years. Mr. Wisner was one of the three United States representatives of the International Water-Ways Commission. He also served formerly on the United States lake survey.

Mr. Julian Griggs, Mem. Am. Soc. C. E., and until March 1 last, city engineer of Columbus, O., has resigned his position of assistant engineer for the Norfolk & Western Railway company, with headquarters at Norfolk, Va., to accept the position of chief engineer of the Scioto Valley Traction Co., located at Columbus, O., effective July 1, 1906.

John W. Maxcy, Houston, Texas, has been appointed arbitrator to act in conjunction with George W. Fuller, of New York City, in fixing the valuation of the water works plant at Denison, Tex. Mr. Maxcy proposes to erect a laboratory plant in Houston, in which mechanical tests, and chemical, bacteriological and metallurgical investigations may be carried on in connection with his general engineering practice.

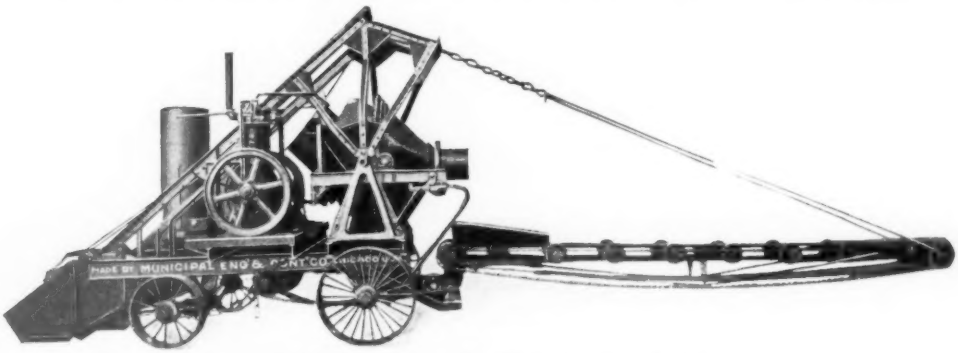
MACHINERY AND TRADE

New Concrete Mixer for Street Paving Work.

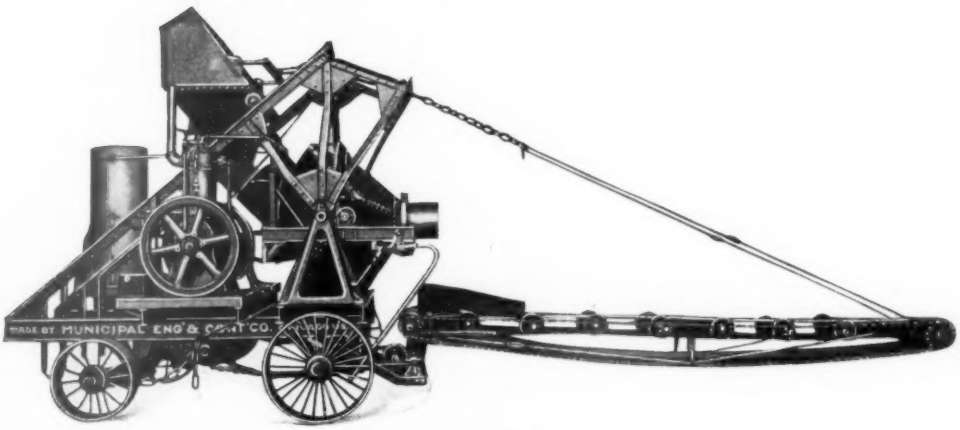
Engineers and contractors fully recognize that concrete mixing machines will produce a more perfect product for street paving and road building than can be obtained by manual labor. Notwithstanding this, heretofore machine mixed concrete has not been extensively used for this purpose, owing to the necessity of frequently moving the machine, and the practical impossibility of keeping it in convenient position for rapid work. Types of machines which have been employed for this purpose usually require the construction of special runways, which must be taken down and set up again at each moving of the machine, and this adds to the expense of machine product. It was also found necessary to receive the mixed concrete from the machine in wheelbarrows and wheel it to the place where the concrete was being laid.

With a view to overcoming the loss in time and labor involved in mixing concrete for street paving work, the Municipal Engineering and Contracting Co., of Chicago, Ill., has recently brought out an entirely new type of machine, embodying a combination of labor-saving devices with automatic action and rapidity of operation, which promises economical

handling of large quantities of concrete in street construction. Two views of this machine are presented in the accompanying illustration. Fig. 1 shows the machine with bucket in loading position; Fig. 2 illustrates the same machine, but with bucket elevated to the top of the charging elevator, showing the position it occupies at the moment the door in the lower portion of the bucket is opened to discharge the aggregates into the mixer. The machine is mounted on trucks, and is arranged to discharge from the rear, instead of the side, as usual, and may be mounted alone with the engine on trucks, if desired, and when placed in this position will effect a saving of space, and is better adapted for street work than the side charge type of machine. The machine is usually made, however, equipped with a charging elevator, but arranged to load from the end instead of the side.



CUBE MIXER, READY TO FILL CHARGING BOX.



CUBE MIXER, CHARGING BOX DUMPING.

The machine discharges on a distributing conveyor, which is also supported on the same truck which carries the machine, and swings through an arc of 160 degrees. This enables the concrete to be spread the entire width of a 50-foot street without the use of wheelbarrows, and requires no hand work other than a small amount of leveling and the necessary tamping.

As illustrated, the cube is discharged by hand power, but this firm equips the machine when desired with an automatic dumping attachment, by means of which the mixer is discharged by the same power which performs the mixing.

In operating the mixer, the charging bucket is lowered to the ground by the engineer by touching a lever to release a cable on the winding drum. Wheelbarrow men load the bucket with the batch in proper proportions within 14 inches of the ground, and there are, therefore, no runways required. If the machine is located in convenient position to the aggregates, wheelbarrows may be dispensed with entirely by partitioning the bucket into proper proportions and shoveling the aggregates directly from the stock piles to the bucket in a single operation. The

batch is hoisted to the top of the elevator, when a door is released in the lower part of the bucket, discharging the batch into the constantly revolving mixer. The charging bucket is then returned to the ground to be reloaded while the batch is being mixed, so that all parts of the work are in continuous operation.

This machine, equipped with all attachments, is operated entirely by one man, who attends to the engine, superintends the operation of the mixer, does both the charging and discharging of the machine, operates the distributing conveyor, and moves the machine forward when required by means of a traction feature.

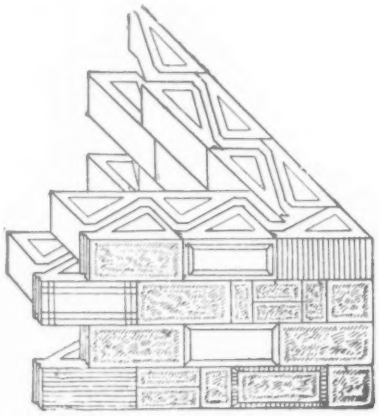
The rapidity with which this type of machine will turn out perfect concrete is practically limited to the time required to load the bucket, elevate it to the top of the charging elevator, and return it to the ground to be recharged. Batches of concrete have been turned out in 38 seconds which were pronounced of excellent quality by competent engineers.

The relative expense of laying street concrete with this mixer, as compared with hand labor, is shown by the following comparison:

In the 1906 edition of Gillette's Hand Book of Cost Data, a number of examples showing the lowest cost in laying concrete in streets 6 inches deep by hand labor was 7 1-2 cents per cubic yard. The makers of this machine assert that if operated to the full capacity, that is, if the bucket is loaded rapidly enough to keep the machine in constant operation, it will turn out a batch of perfect concrete a minute, and maintain this speed indefinitely. If the mixer, however, were operated at a rate of only 45 batches per hour the output would be 15 cubic yards, or 90 square yards, 6 inches thick, per hour, and making the extremely liberal allowance of 18 men to operate the machine, with wages averaging 17 1-2 cents per hour, this would be $3.15 per hour for labor. Figuring wages at this price, the cost of laying a square yard of concrete 6 inches deep with the machine would be 3 1-2 cents, or less than half the expense of the lowest example recorded for hand labor.

The Pegram Improved Building Block.

The Pegram improved concrete building block is produced by dividing the single piece block diagonally across corners as well as the core openings. This makes what is known as a two-piece wall, with hollows in the blocks, which lay up a triple hollow wall and produce a right-angled triangle block. A block of this shape has proved an excellent system for a two-piece wall, as it insures a perfectly dry inside wall, thus enabling plastering direct over the wall. A wall laid up of right-angled triangular blocks gives a continuous air space running horizontally throughout the wall, there being no contact between the inner and outer wall. By making the outside block from a better mixture of material than the inside block, it will be of better appearance than the inside block, produced from gravel and coarser material, although the inside block will be equal in strength and a great deal cheaper.



PEGRAM TRIANGULAR BUILDING BLOCK.

The block will appeal to the judgment as to strength, and the three separate air passages in the wall make the best ventilated wall attainable, it not being necessary to fur and lath for plastering. A guarantee is given with each machine covering wall ventilation; which enables all makers of the Pegram right-angled triangle blocks to guarantee absolutely dry walls to their customers.

The Reed machines produce two blocks at the same operation and when operated to full force, two men, counting the material mixed and run into the hopper, 800 lineal feet of 9-inch to 11-inch wall is produced. When a different design is desired only a new face plate is necessary and not an entire machine. With the Reed stationary mold box the blocks are produced from a wetter mixture than can be used in an opening mold. No time is wasted taking out grains of sand, fastening up and unfastening the mold box or using a square at each operation. The Reed machine produces both the Pegram right-angled triangle and the single double-hollow blocks. The single double-hollow block is desirable for work where

the walls are not to be plastered over. The Reed produces blocks from 8 inches to 32 inches in length.

The following problem is offered by the makers: How many different sizes of single molds would be required to produce the same variety of dimensions of blocks? Answer: Basis of adjustment, 1-16 of an inch, 15,728,640 single molds; basis of adjustment 1 inch, 3,840 single molds; basis of adjustment 2 inches (which is required in general work), 480 single molds. Have you ever figured the advantage of owning an adjustable mechine?

The operators claim that the economical and preferable method of caring for blocks is to take the blocks away from the machine and not the machine away from the blocks, thus decreasing the risk of ruining the blocks. Each block ruined is money lost. The Reed is so simple any one can operate it; so rapid that it only depends on the activity of the operator for speed; so durable it will last a lifetime. These claims by the manufacturers of the machine are worth full investigation. They are prepared to manufacture any design of face plate and have a very large assortment to choose from.

The Wichita Coal and Material Co., Wichita, Kan., will be pleased to tell more about the right-angled triangle blocks and operations of the Reed machines to those addressing them.

Paving Materials in New England Cities.

The city of New Britain, Conn., has adopted bitulithic for future permanent paving. Previous to this City Engineer Oldershaw sent out communications to several cities, asking for information regarding permanent pavements, in answer to which the following were received:

New Bedford, Mass.—City has 2,855 square yards of bitulithic pavement, which was laid in 1901; 10,790 square yards, 1904; 1,358 square yards, 1905, all with a five years' guarantee at $2.20 per square yard. The 1901 pavement had a soft top and did not wear as well as the rest, which gave excellent service. The writer recommended this pavement here, where trap rock could be obtained cheaply. The city engineer said that they used a soft granite stone there.

Woonsocket, R. I.—Bitulithic, Barrington brick and asphalt used; result, asphalt, constant repair needed after three years, bitulithic best, showed no repair and has rough surface.

Cambridge, Mass.—Bitulithic, Johnsonburg and Canton, O., brick, asphalt; result, asphalt slippery, needs constant repair; brick, too noisy; bitulithic best in every respect.

Holyoke, Mass.—Bitulithic, Catskill and Mack brick, asphalt; opinion, for heavy traffic, brick; medium traffic and steep grade, bitulithic, and is liked best by teamsters and horsemen.

Providence, R. I.—Bitulithic, New England Steam Brick Co.'s brick, asphalt; result, bitulithic best, brick good when traffic is not too heavy.

Brookline, Mass.—Bitulithic found an excellent pavement and would recommend it; bricks are wearing well; asphalt constantly needs repairing.

Somerville, Mass.—Bitulithic recommended, no fault found with it; brick noisy and wears quickly; asphalt needs repairing quickly.

Lynn, Mass.—Bitulithic recommended for its sanitary qualities and durability; brick has worn well.

Lowell, Mass.—Bitulithic has given excellent service; brick are in good condition; asphalt, some good, some poor.

Everett, Mass.—Bitulithic is as durable as any.

An Asphalt Filler for Block Paving.

A specially valuable feature claimed for the asphalt paving fillers, made by the Sun Company, is the wide range of temperatures in which they are efficient. Their Hydrolene B 200, for example, is ductile at zero and below, and does not melt until the particular melting point for which it is manufactured is reached. It therefore remains in the joints, does not crack or break up in winter, as many coal tar fillers do, and does not adhere to feet or wheels in summer. Being pliable, expansion and contraction of the pavement are provided for. The company has had great success with the filler in this country and in Europe and has for some time been unable to solicit new business, but has now increased its facilities so that prompt shipments can be made on new orders. The Sun Company, Real Estate Trust Building, Philadelphia, Pa., will give full information and show samples.

Trade Publications.

The Reading Iron Co., Reading, Pa., publishes an argument in favor of wrought iron pipe, in the form of a legal brief, so far as the title page is concerned.

The Wichita Coal and Material Co., Wichita, Kan., issue a large descriptive catalogue of the Reed cement working machinery, for making blocks and bricks by various methods, giving full descriptions and instructions for operation and many arguments for the method of con-

struction. There are many illustrations of structures. Mixing machines, pipe molds, gas engines and tampers are included in the catalogue.

The Baldwin concrete mixer, sold by the Waterloo Cement Machine Co., 317 Lafayette building, Waterloo, Ia., is described in an illustrated circular.

One of the most attractively illustrated catalogues of recent issue is that being sent out by the Hayden Automatic Block Machine Co., of Columbus, O. It is generously illustrated with the various products of this concern and contains a large number of new styles of concrete blocks, balls, posts, etc. The cover design is very attractive and altogether it makes a handsome addition to their large line of literature.

The Reinforced Concrete Pipe Co., formerly the Jackson Cement Sewer Pipe Co., Jackson, Mich., have issued a very handsome booklet, giving thanks for their good business in the past and explaining and illustrating their method of making and laying reinforced concrete sewer pipe, manholes and catch basins. The accompanying illustrations, letters and newspaper articles show the satisfactory nature of their work.

Trade Notes.

ASPHALT.

Bluffton, Ind.—City Council has decided to purchase an asphalt mixing plant and repair and resurface its own streets, using a guarantee fund to do the work.

Perth Amboy, N. J.—A fire started in the roofing department of the Barber asphalt plant, July 1, destroying several tons of materials and threatening for a time to destroy the entire plant.

Spartanburg, S. C.—The Atlantic Bitulithic Company has been organized and directors elected as follows: George C. Tenney, Spartanburg; W. H. Borin, Norfolk, Va.; J. L. Pool, Spartanburg; J. T. Maxwell, Saugerties, N. Y.; Ralph E. Warren, Boston, Mass. Officers were elected as follows: President and treasurer, George O. Tenney; vice-president, W. H. Dorin; auditor, J. L. Pool. The main office will be located in this city, with a branch office in Norfolk, Va. The company will do contracting business, such as street and sidewalk paving, water works, sewerage, etc.

New Orleans, La.—Special. The finance committee of this city received bids, June 25, for furnishing 1,500 tons of asphalt for its municipal asphalt paving plant. Bids were received from the California Asphaltum Sales Agency, the Barber Asphalt Co., the A. L. Barber Co., the Globe Asphalt Co. and the Warren Asphalt Co. The contract was awarded to the California Asphaltum Sales Agency, the lowest bidder, at $18.50 per ton for its Maltha brand.

BRICK.

Tulsa, I. T.—The Tulsa Vitrified Brick Co. and the Tulsa Red Fork Brick Co. have consolidated, with E. B. Howard as president and general manager of the merger.

Port Huron, Mich.—The Cement Brick Co. has installed a large sand-lime brick plant at Glens Falls, N. Y.

Auburn, Ill.—The Auburn Brick, Tile and Cement Co. has been incorporated by Philip Faust, Joseph Reilhe and Entie Faust.

Coffeyville, Kas.—The Yoke Vitrified Brick Co. has been organized and will erect a plant here, to be equipped with machinery furnished by the American Clay Machinery Co., of Bucyrus, O.

Chattanooga, Tenn.—The Mission Ridge Clay Co. has been incorporated by H. C. Brown, John D. Key, Samuel B. Smith, T. T. Rankin and Norris Headrick.

CEMENT.

Independence, Kas.—The board of directors of the Western States Portland Cement Co. held its regular meeting in this city, June 19. A dividend of $210,000, or 14 per cent. on its preferred stock, amounting to $1,500,000, was declared. The company's plant was completed last fall, but active operations were not well under way until last December.

Dixon, Ill.—The Sandusky Portland Cement Co., of Bay Bridge, O., has been incorporated to do business here.

Toledo, O.—The plant of the United States Gypsum Company, near here, was destroyed by fire, July 3, entailing a loss of $150,000 and throwing 150 men out of employment.

New York City.—The Monse Lime Co. has been incorporated to manufacture lime, cement, etc., by Frank E. Monse, Benjamin L. Belknap, D. C. Wilsey, Edwin B. Monse, 17 State street, and John T. Booth, 371 Broadway, all of New York City.

Corsicana, Tex.—S. W. Bogy and associates contemplate organizing a company for the development of cement deposits which they control here.

Mason City, Ia.—The Lehigh Valley Cement Co., of Pittsburg, Pa., has secured options on 640 acres of land here, and will establish a cement plant.

South Bend, Wash.—W. A. Winsboro, of Portland, Ore., has purchased a tract of land on Bear river, near here, and will have tests made of the materials available, with a view to establishing a cement plant.

Baker, Wash.—The plant of the Washington Portland Cement Co. is to be completed and ready for operation about Aug. 1. E. C. Miller, manager.

Syracuse, Ind.—The plant which the Art Portland Cement Company is erecting at Kimmell, Ind., is rapidly nearing completion, and it is probable that cement will be put on the market about Aug. 15. The officers of the company are: President, George W. Miles, Syracuse, Ind.; vice-president, William C. Hillabold, Chicago; secretary and treasurer, Orean W. Christy, Ligonier, Ind.; manager and chemist, Melville M. Smith, Syracuse, Ind.; superintendent and engineer, Edward Hoykendorf, Kimmell, Ind.

CONCRETE BLOCKS.

Kemara, N. D.—Clark & Hawkins, cement block manufacturers, have dissolved partnership, G. V. Clark succeeding in the business.

Detroit, Minn.—The Holmes Artificial Stone and Brick Co. is enlarging its plant by the installation of a new gasoline engine to operate the mixet, elevator and other machinery.

Milwaukee, Wis.—The National Concrete Machinery Co. has been incorporated by Otto Gelhaar, J. P. Sherer, S. T.

Walker and Alfred T. Rogers.

Milwaukee, Wis.—The Wisconsin Foundry Co. has been organized here and will engage in the manufacture of cement mixtures by J. R. Smith, A. E. Smith and Gerhard Mockley.

New concrete block companies:

Hawley, Minn.—Lewis Bros.

Janesville, Minn.—Bradford Chase.

Gravity, Ia.—George Oxley.

Fort Pierre, S. D.—A. W. Barker.

Ulen, Minn.—Ulen Cement Stone Co., Ed C. Dahl and Henry Ericksoon.

Milwaukee, Wis.—The Badger Cement Products Co., Edward J. Bowler, William Rockring and John J. McGuckon.

Green Bay, Wis.—The Concrete Construction Co., T. J. McGrath, manager.

Milwaukee, Wis.—John H. Radke has put in operation, at 706 Kinnickinnic avenue, a plant where he contemplates making a brick from slag from the foundries, ground fine and mixed with cement, pressed, then steamed and baked. The name of the firm will be the Milwaukee Steel Brick Co.

PURCHASE OF MATERIALS.

Newton, Kas.—Special. John Early, 114 E. Broadway, advises us that he is in the market for a block machine and sidewalk, curb and gutter tools.

Beloit, Wis.—Special. The Inman Concrete Building Block and Machine Co. desires to purchase a mixer, pneumatic tampers and pneumatic block machine or press.

Bluffton, Ind.—City Council has decided to purchase an asphalt repair plant.

PURCHASE OF MATERIALS.

Beloit, Wis.—Special. The Inman Concrete Building Block and Machine Co. is in the market for cement and hydrated lime.

Newton, Kas.—Special. John Early, 114 E. Broadway, is in the market for cement.

Marion, Ind.—Special. Evan H. Ferree advises that he is in the market for paving materials.

LIGHT, HEAT AND POWER.

Elizabeth, N. J.—The New Process Construction Co. has been incorporated to manufacture, sell and supply gas for the production of light, heat and power, and to erect and maintain works for the making and distribution of gas. The incorporators are Wm. C. Finck, of Elizabeth; Wm. P. Stevenson and Walker W. Stevenson, of Roselle.

Camden, N. J.—The Electric Service Supplies Co. has been incorporated by Edwin B. Ross, John McSurley and A. H. Englund, to deal in electrical and mechanical apparatus and supplies. N. J. Guarantee and Trust Co., agent in charge.

MISCELLANEOUS.

Dallas, Tex.—The Municipal Paving Co. has been incorporated by B. R. Anderson, F. O. Brown and W. L. Switzer.

Norfolk, Va.—The Ocean View Boulevard Corporation has been incorporated.

Birmingham, Ala.—The Birmingham Construction and Paving Co. has been incorporated to do general paving and constructing work, with offices in this city. The officers of the company are: President, R. Fies; general manager, John Donnelson; secretary-treasurer, Eugent Fies.

Cleveland, O.—Special. The F. D. Cummer & Son Co., Cleveland, O., reports the demand for its Cummer Self-Contained Dryers constantly increasing. Within the past few weeks orders have been received from Bona, Algeria, for two dryers, for drying phosphate; one from a large paving company for a large dryer for drying sand; one from a large distillery in Chicago, for drying distillery grains; one from Pittsburg, for drying glass sand, and one from East Liverpool, O., for drying glass sand. An order for a Cummer Direct Heat Brick Dryer from Millsdale, Ind., has also been received.

Patents Concerning Cement and Its Uses.

801,845. Oct. 17, 1905. Molded Fence Post. Thos. H Bradley, Lexington, Ky.

801,896. Fence Post. Esek McDaniel and Wm. R. McCallister, Paris, Ill.

801,915. Mold for Culvert, Sewer and Other Pipes. John Robinson, Hamilton, Can.

801,920. Building Block and Wall. Rudolph J. Schwab, Milwaukee, Wis.

802,004. Centering for and Method of Constructing Arches. Daniel B. Luten, Indianapolis, Ind.

802,143. Fence Post. James F. Haffey, Tiffin, Ohio.

802,223. Armed Building Stone. Jens G. F. Lund, Christiania, Norway.

802,506. Oct. 24, 1905. Fireproof Stairway. Francis O. Hanson, Chicago, Ill.

802,593. Building Block. Geo. L. Peabody, Pittsburg, Pa.

802,631. Apparatus for Burning Portland Cement Clinker. Thos. A. Edison, Llewellyn Park, N. J.

802,666. Apparatus for Molding Concrete Structures. Carl Stieler, Chicago, Ill.

802,699. Molding Apparatus. Charles F. Lancaster, Petoskey, Mich.

802,718. Machine for Molding Plastic Materials. Geo. Stewart, New York, N. Y.

802,772. Curb. John F. McCoy, New Orleans, La.

802,795. Cement Tie and Rail Fastening Therefor. John G. Archibald, Bayside, Mich.

802,848. Molding Machine for Making Building Blocks. Wm. E. Dunn, Chicago, Ill.

802,903. Building Block and Wall Construction. Zacharius Anderson, Minneapolis, Minn.

802,915. Railway Track Construction. Edward E. Clement, Washington, D. C.

803,014. Oct. 31, 1905. Machine for Producing Artificial Stone. David McIlravy, Riceville, Iowa.

803,016. Conveyor for Artificial Stone. Floyd Palmer, Washington, D. C.

803,023. Mold for Forming Cement Receptacles. Ora Staley, Charlottesville, Ind.

803,089. Hanger for Building Purposes. Chas. H. Bigelow, Jr., St. Paul, Minn.

803,092. Machine for Making Artificial Stone. Valentine Bueckermann, Chicago, Ill.

803,103. Wire Fence Fastener. Wm. G. Hartmann, Conklin, Mich.

803,271. Mold for Plastic Material. Frank F. Cole, Albion, Mich.

803,290. Building Block and Wall Construction. Olof Johnson, Estherville, Ia.

803,380. Building Block. John Wickre, Williamsburg, Va.

803,530. Furnace for Burning Cement, etc. Gustaf Groendal, Djursholm, Sweden.

803,615. Nov. 7, 1905. Cement Fence Post. Asa Moler, Iowa City, Iowa.

803,680. Device for Forming Concrete Sewers. Robert R. Evans, Haverhill, Mass.

803,703. Device for Building Concrete Walls. David A. Milam, Kansas City, Mo.

803,706. Cement Post Fastener. Henry McMaster, Detroit, Mich.

803,721. Mixing Machine. Thomas L. Smith, Milwaukee, Wis.

803,751. Composite Railroad Tie. Hugh J. Foxnier, Chicago, Ill.

803,785. Cement Fence Post. Judson K. Purniton, Des Moines, Iowa.

803,823. Cement Block Machine. John I. Hancock, Lestershire, N. Y.

803,852. Metal and Concrete Construction. Chas. L. Raymond, Rochester, N. Y.

803,861. Concrete Fence Post. Casper Spress, Norwood, Minn.

803,865. Cement Block Machine. Daniel W. Weller, Phoenixville, Pa.

803,923. Railway Tie. Jas. R. McFall, St. Louis, Mo.

804,076. Rotary Kiln. Wm. R. Warren, New York, N. Y.

804,122. Mold for Building Blocks. Chas. J. W. Hayes, Detroit, Mich.

804,167. Form for Making Cisterns and Cesspools. Edgar H. Osborn, Battle Creek, Mich.

804,169. Mold for Building Brick. Wm. Porten, St. Paul, Minn.

804,237. Nov. 14, 1905. Centering for Concrete Floors. Paul Kuehne, New York, N. Y.

804,240. Flask for Molding Concrete Blocks. Thos. Libby, Minneapolis, Minn.

804,261. Concrete Mixer. John W. Page, Chicago, Ill.

804,423. Machine for Making Cement Blocks. John Miller, Minneapolis, Minn.

804,528. Machine for Molding Cement Blocks. Thos. Fischer and Jas. B. Tabbot, Edwardsville, Ill.

804,614. Means for Reinforcing Concrete Structures. Robert R. Moorman and Chas. W. Yelm, Lafayette, Ind.

804,643. Molding Machine. Harry A. Walter, Marshall, Mich.

804,711. Fence Post. Jas. M. Elder and Anderson W. Means, Indianapolis, Ind.

804,753, 804,754. Roofing Tile and Tile Molding Machine. Henry Meyer, Deshler, Ohio.

804,890. Nov. 21, 1905. Mold for Manufacture of Cement Brick. Wm. A. Shock, Huntington, Ind.

804,939. Retaining Wall. Wm. H. Ferguson, San Francisco, Cal.

804,944. Cement Roofing Tile Making Machine. Alfred Gaspary, Markranstaedt, near Leipsic, Germany.

805,018. Molding Apparatus. Wm. F. Keslin and Wm. N. May, Rockfield, Ind.

805,045. Machine for Making Concrete Blocks. Edgar M. Walton, Kansas City, Mo.

805,137. Ceiling. Wilhelm Hubst, Steglitz, near Berlin, Germany.

805,213. Rotary Kiln. Jas. H. Logan and Wm. H. Simmons, Fenton, Mich.

805,294. Machine for Making Cement Brick and the Like. Fred C. Hohn, Indianapolis, Ind.

805,418. Mold. Robert T. Frost, Dows, Iowa.

805,457. Nov. 28, 1905. Adjustable Mold for Making Building Blocks. Joseph B. Francisco, Columbus, Ohio.

805,478. Concrete Building Block. Edgar L. Lorscheider, Chicago, Ill.

805,642. Cement Stone Machine. Joe Geers and Wm. Mehrle, Jersey City Heights, and Johann Wiemkes, Hoboken, N. J.

805,655. Mold. Wm. H. Lucas, Newark, Ohio.

805,663. Reinforcing Device for Concrete Construction. Geo. L. Peabody, Pittsburg, Pa.

805,754. Machine for Pressing Plastic Material. Ebenezer W. Rider, Detroit, Mich.

805,762. Framework for Cement Structures. John S. Thomas and Wm. M. Thomas, St. Louis, Mo.

805,819. Mold for Concrete Walls. August F. Reichert, Milwaukee, Wis.

805,883. Apparatus for Forming Concrete Walls. Colonel E. Russell, Chicago, Ill.

805,884. Roofing Tile. Lloyd G. Satterlee, Rochester, Mich.

805,914. Machine for Making Cement or Concrete Blocks. Jacob Horr, Mechanicsburg, Ohio.

805,936. Concrete Pile and Method of Making Same. Frank Shuman, Philadelphia, Pa.

805,953. Cement Burning Kiln. Guy D. Helmick, Ft. Russell, Wyo.

805,962. Mold for Artificial Stone. Jas. M. Hutchinson, New York, N. Y.

806,066. Mold. Edwards A. Cimmery and Noah W. Mottinger, Manistee, Mich.

806,146. Dec. 5, 1905. Process of Manufacturing Portland Cement. Edward H. Hurry, Bethlehem, and Harry J. Seaman, Catasauqua, Pa.
D. Kneedler, Sioux City, Iowa.

806,161. Manufacture of Hydraulic Cement. Wilhelm Michaelis, Berlin, Germany.

806,281. Fence Post. Joseph D. Paldi, Yale, Mich.

806,324. Burial Vault. Samuel J. Cowles and John B. Murray, Findlay, O.

806,371. Machine for Manufacturing Hollow Artificial Stone Beams or Girders. Hans Siegwart, Lucerne, Switzerland.

806,686. Vault Mold. Wm. H. Lucas, Newark, Ohio.

806,718. Fence Post. Wm. E. Wilson, Graysville, Ohio.

806,743. Post. Eugene R. Hurlburt, Mt. Zion, Ill.

806,788. Dec 12, 1905. Method of Aging Portland Cement. Wm. O. Emery, Crawfordsville, Ind.

806,832. Fastening Device for Use in Building Construction. Emile G. Perrot, Philadelphia, Pa.

806,838. Method of and Means for Forming Concrete Piles. Alfred A. Raymond Chicago, Ill.

806,911. Building Block. Wm. L. Phillips, Broken Bow, Neb.

806,927. Cement Block and Brick Machine. Taylor F. Shoemaker, Bluffton, Ind.

807,062. Cement Mold. Robert B. Coltrin, Jackson, Mich.

807,207. Machine for Mixing Concrete. Geo. D. Scheiffler, Jackson, Mich.

807,313. Concrete Railroad Tie. Chas. Pelenulder, Grant City, Iowa.

807,438. Dec. 19, 1905. Fence Post. Elnathan Calout, Des Moines, Iowa.

807,469. Fence Post. Aaron E. Jester, Wentworth, Mo.

807,488. Fence Post. Jos. A. McDaniel, Letts, Iowa.

807,522. Concrete Mixer. Daniel Warner, Bronson, Mich.

807,833. Machine for Molding Bases on Fence Posts. Charles S. Long, Aurora, Ill.

807,899. Cement Mixer. Chas. L. Baldwin, Waterloo, Iowa.

807,935. Mold Support. Wm. S. Jackson, Veedersburg, Ind.

808,039. Metal Fabric for Use in Concrete and Other Purposes. John F. Golding, Washington, D. C.

808,167. Dec. 26, 1905. Mold (for Pipes). Edward F. Nevins, Blue Rapids, Kan.

808,394. Mold for Cement Fence Posts and the Like. John J. Luck, Aurora, Ill.

808,401. Rail Fastening for Plastic Ties and Process of Making Same. Herbert E. Percival, Galveston, Tex.

808,431. Building Block. Theodore H. Brown, Northfield, Minn.

808,643. Jan. 2, 1906. Cement Block Machine. Matthew Eckley, Archbold, O.

808,836. Method of Mixing Concrete. Peter C. Hains, Washington, D. C.

808,846. Mold (for Cisterns, etc.). Jas. H. Johnson and Henry Meyer, Fort Recovery, Ohio.

808,900. Tool for Making Artificial Stone Walks. Patrick F. Connelly, Sioux Falls, S. D.

808,969. Fence Post. Michael L. Boyce, Carroll, Iowa.

809,090. Interior Concrete Structural Work. Frank C. Caine, Cleveland, Ohio.

809,106. Wall Mold. John H. Gehr, Waynesboro, Pa.

809,199. Mold (for Cisterns, etc.). Wm. H. Lucas, Newark, Ohio.

809,250. Cement Brick Machine. Fred B. Dysart, Superior, Neb.

809,251. Cement Tile Machine. Fred B. Dysart, Superior, Neb.

809,252. Cement Block Machine. Fred B. Dysart, Superior, Neb.

809,367. Jan. 9, 1906. Block Molding Machine. Harvey P. Gates, Remington, Ind.

809,452. Machine for Molding Hollow Walls. Israel L. Landis, Chicago, Ill.

809,629. Burial Vault Mold. John M. Pruett and Jacob C. Simpson, Rockville, Ind.

809,680. Method of Making Pipes of Artificial Stone. Joseph Hall, Cheltenham, England.

809,834. Cement Block Press. Horace B. Murdock, Detroit, Mich.

809,897. Burial Vault. Joseph P. Bending, Otway, Ohio.

809,901. Concrete Block Machine. John A. Blake and Jay Kemich, Wolcott, Ind.

809,906. Fence. Jas. H. Brown, St. Charles, Ill.

809,940. Jan. 16, 1906. Tile Molding Machine. Allen Glenn, Scranton, Iowa.

810,019. Cement Block Machine. Gorman J. Apgar, Robinson, Ill.

810,025. Machine for Molding Concrete Blocks. Walter G. Bennett and John F. Seyfang, Toledo, O.

810,050. Concrete or Cement Post or Analogous Structure. Geo. F. Greene, Detroit, Mich.

810,053. Flask for Molding Concrete Blocks. John Harum, Minneapolis, Minn.

810,220, 810,221. Reinforcing and Tension Devices for Use in Concrete Structures. S. Pierson, Morristown, N. J.

810,276. Mold for Drain or Sewer Pipes. Jas. B. Hill, Findlay, Ohio.

810,300. Machine for Making Blocks or Tiles. Daniel I. and John E. Pettit, Grand Junction, Iowa.

801,343. Concrete Block Mold. John M. Pettijohn, Terre Haute, Ind.

810,382. Mold for Cement Construction Blocks. Malva M. Robertson, Des Moines, Iowa.

IMPROVEMENT AND CONTRACTING NEWS

PAVING.

Washington, D. C.—The plan of co-operation for the improvement of public roads, which was instituted several months ago by the Postoffice Department, the Department of Agriculture and various state highway officials, has resulted satisfactorily, according to a communication sent to the Postoffice Department by the state engineer and surveyor of New York. He states that a bulletin is to be issued, furnishing directions and suggestions for the guidance of town officials having care and authority over public highways in the state of New York, and that it is desired to publish therein the requirements of the department relative to the establishment and continuance of rural delivery routes.

Bay City, Mich.—Suit has been filed in the circuit court by Patrick Ryan against this city, claiming damages for $5,000. The suit grows out of the construction of a brick pavement on Cass ave. in 1903. Council gave permission to the Bay Cities Consolidated Co. to build a line on 36th st. during the construction of the pavement, so as to facilitate the work, but subsequently rescinded such action without notifying the plaintiff. Mr. Ryan claims that his bid was made according to the former action, the contract price being $26,208. He says that while performing the work in accordance with the spirit, terms and specifications of the contract and to the satisfaction of the board of public works, common council caused him and his employes to be forcibly ejected and prevented him from completing the work.

CONTEMPLATED WORK.

Little Falls, Minn.—Paving is proposed for 1st ave.

Opelousas, La.—Paving ordinances have been adopted.

Hayfield, Minn.—Cement sidewalks have been authorized.

Waterloo, Ia.—Asphalt paving is contemplated for Sycamore st.

Brainerd, Minn.—Paving is contemplated for N. Broadway st.

Ilion, N. Y.—The street bd. has decided to macadamize 3d st.

Hudson, Wis.—Sidewalks are contemplated.

Beardstown, Ill.—A number of the business streets will be paved.

Adrian, Mich.—Paving is contemplated for College ave. and Broad st.

Sparta, Wis.—Council voted to construct 1500 ft. of macadam paving.

Enid, Ok.—City council has decided to pave with brick or asphalt.

Birmingham, Ala.—Brick paving has been decided upon for 1st alley.

Zanesville, O.—Vitrified brick paving is proposed for Webster ave.

Springfield, Ill.—S. Grand ave. boulevard is to be paved with asphalt.

Ottumwa, Ia.—Brick paving is contemplated for Pearl st.

Rochester, Minn.—Council has decided to pave W. Zumbre st. with brick.

Elm Grove, Tenn.—City voted to issue $14,500 for paving the National pike.

Boone, Ia.—Council has authorized the construction of permanent sidewalks.

Martinton, Ill.—City council has decided to construct more cement sidewalks.

Ashland, Ky.—Ordinance adopted to pave 14th st., from Carter to Central ave.

Fond du Lac, Wis.—Macadam paving is contemplated for 5th st. and asphalt for 1st st.

Valley Junction, Ia.—Council has ordered the construction of permanent sidewalks.

Tacoma, Wash.—A resolution is pending providing for brick paving on Puyullap ave.

Grand Island, Neb.—The property owners have petitioned for the paving of an alley.

Joliet, Ill.—A resolution has been passed for constructing a cement walk on Van Buren st.

Kirksville, Mo.—Bids will be asked soon for paving 1 1-2 miles of street with concrete.

Bozeman, Mont.—Council has ordered the construction of concrete sidewalks on Lindley Pl.

Harrisburg, Pa.—Mayor E. Z. Gross has signed the ordinance for paving Harris st. with asphalt.

Springfield, Ill.—Ordinance passed to pave Walnut st., from Jefferson st. to N. Grand ave.

Dodgeville, Wis.—A cement sidewalk has been authorized on Main st., from Diagonal to Spring sts.

Niles, Mich.—About 3-4 miles of asphalt paving is contemplated on 5th st. Matthew Stoll, mayor.

Ft. Wayne, Ind.—Buchanan and Tabor sts. and Fairfield ave. will be paved with asphalt this year.

Averyville, Ill.—Brick paving is contemplated for Vine st. and cement sidewalks for Alexander ave.

South Omaha, Neb.—The bd. of co. comrs. has appropriated $35,000 for improving W. "Q" st. with brick.

Mobile, Ala.—About 50,000 sq. yds. of street paving is contemplated. Stewart Brooks, prest. B. P. W.

Edgewood, Va.—Town council is securing estimates on the cost of curbing and paving the sidewalks.

Bloomington, Ill.—A petition is being circulated, asking that Market st. be resurfaced with asphalt.

Racine, Wis.—The construction of about 6 miles of cement and brick sidewalks will be built this year.

Vancouver, B. C.—A by-law has been adopted authorizing the construction of 15 miles of cement sidewalks.

Wichita, Kas.—A resolution has been passed providing for vitrified brick paving on Wichita st. R. N. Dorr, cy. clk.

San Francisco, Cal.—Bids will be asked soon for paving Market st. from 2nd to East sts. Thos. P. Woodward, cy. engr.

Covington, Ind.—Bids will be asked soon for 12,000 sq. yds. of vitrified brick paving. Cy. coun. or W. B. La Baw, engr., Veedersburg.

Crawfordsville, Ind.—Hearing will be given Aug. 20 on the proposed construction of cement curb and gutter on Walnut, Pike and Pine sts. Henry B. Hulett, cy. clk.

New Orleans, La.—Uniform paving for Howard ave., from Lee Circle to the Illinois Central Station in Rampart st., is contemplated, the residents along the street to designate the material.

Sherman, Tex.—Vitrified brick paving is contemplated for W. Mulberry and others streets. C. E. Hayden, cy. engr.

Halifax, N. S.—City council has decided to construct concrete sidewalks on South st. and Spring Garden rd.

Knoxville, Tenn.—The city recorder has been instructed to advertise for bids for paving 14 improvement districts.

Vicksburg, Miss.—Bids will probably be received about Sept. 1 for 25,000 sq. yds. of bitulithic or brick paving.

Monmouth, Ill.—Bids will be asked soon for 10,000 sq. yds. of paving with sandstone curbing. J. L. Bates, cy. engr.

Martins Ferry, O.—Bids will be asked soon for 15,000 sq. yds. of vitrified block paving. C. P. Lash, cy. engr.

Colorado Springs, Colo.—An ordinance has been passed providing for the construction of 44 blocks of sidewalks.

Uhrichsville, O.—An ordinance has been passed to pave 2d st., from Center to Wilson, with brick. D. C. Mahon, mayor.

Vinita, I. T.—An ordinance was passed July 11, providing for 6 blocks of brick paving on Illinois ave. and Wilson st.

Petersburg, Pa.—Resolutions have been passed for constructing granolithic sidewalks on many of the principal streets.

Clarinda, Ia.—A resolution has been passed providing for grading, paving and curbing of 16th st. C. W. Stuart, cy. clk.

Parkersburg, W. Va.—Bids will be asked about Aug. 1 for 10,000 sq. yds. of vitrified brick paving. J. V. Dunbar, cy. engr.

Mingo Junction, O.—Ordinances have been passed to pave Junction and S. Commercial sts. with brick. Frank McLister, clk.

Racine, Wis.—The question of paving Main st., from the C., M. & St. P. tracks to 6th st., with brick or asphalt is being agitated.

Houston, Tex.—The city engr. has been directed to prepare plans and specifications for paving Hamilton st., from Leland to Gray.

Wichita, Kas.—A resolution has been adopted for paving Wichita st. and Emporia ave.; also to advertise for bids for paving 1st st.

Freeport, Ill.—An ordinance has been passed for grading, macadamizing and curbing West st., from Elk to Empire sts. Mayor Dittmar.

Marion, O.—Petitions are being considered for the construction of sandstone sidewalks on Erie, Mound and Carhart sts. and Irey ave.

Kalamazoo, Mich.—The Commercial club is considering a proposition for con-

structing an 8-mile boulevard along the east and south sides of this city.

Aurora, Ill.—Ordinances have been passed for paving W. Park ave. and Clark and Broadway sts., Iowa and Lincoln aves. will be paved with asphalt.

Columbus, O.—An ordinance has been approved for paving Bolivar st., from Mt. Vernon ave. to Whitcomb st., with brick. Geo. W. Rightmire, prest. coun.

East Liverpool, O.—The construction of 5,000 sq. yds. of bitulithic and 1 mile of asphalt block paving is contemplated. Charles Kelly, cy. engr.

Dayton, O.—A resolution has been passed to pave Monument ave. with brick, sheet asphalt, bituminous macadam or creosoted wood blocks. Calvin D. Wright, prest. coun.

New York City—The bureau of highways is reported as having announced its intention to pave practically all of the streets in the office building district with wood.

Neenah, Wis.—City council rejected, July 16, the plans for brick paving on E. Wisconsin ave. and N. Commercial st. and voted to construct macadam pavements. Mayor Schultz.

Burlington, Ia.—A resolution was approved July 17 for paving Grove st., from May st. to Garfield ave., with brick on concrete with artificial stone curbing. F. L. Unterkircher, mayor.

Lynchburg, Va.—W. B. Keyes, of Norfolk, has purchased 170 acres of land in West Lynchburg and will develop it as a suburban residence site, constructing concrete sidewalks, asphalt roadways, sewers and water mains.

Indianapolis, Ind.—Asphalt paving is contemplated for 22d st., from College to Central aves. Cement sidewalks will be constructed on 30th st., from the canal to White river. Bitulithic paving has been decided upon for Lexington ave., from State ave. to Shelby st.

Hamilton, O.—City Engr. Dillon estimates the cost of paving S. 2d st., from Wood st. to Crawford's Run, as follows: Bitulithic or sheet asphalt with combined curb and gutter, $31,193; stone curb and gutter, $30,673.50; brick, $27,116. Maple ave.: Bitulithic or sheet asphalt with combined curb and gutter, $31,927.50; stone curb and gutter, $30,593.50; brick, $27,815.

CONTRACTS TO BE LET.

Green Bay, Wis.—Bids are asked until Aug. 13 for macadam paving. Cy. clk.

Brownstown, Ind.—Bids are asked until Aug. 7 for constructing 4 gravel roads. Co. audt.

Vincennes, Ind.—Bids are asked until Aug. 7 for constructing 7,792 ft. of gravel roads. Co. comrs.

Valparaiso, Ind.—Bids are asked until Aug. 6 for constructing 9,400 ft. of gravel road. Co. Audt. Corboy.

Columbus, Ind.—Bids are asked until Aug. 6 for constructing 1 mile of gravel road. Co. comrs.

St. Paul, Minn.—Bids are asked until Aug. 6 for grading Edgerton st. E. G. Krahmer, co. audt.

Ashland, O.—Bids are asked until Aug. 6 for grading and paving Walnut st. A. S. Miller, mayor.

Pontiac, Mich.—Sealed bids are asked until Aug. 6 for paving Jackson st. Joseph H. Thorpe, cy. clk.

Paoli, Ind.—Bids are asked until Aug. 8 for building 10,600 ft. of road in Northeast twp. Co. comrs.

Danville, Ill.—Bids are asked until 7:30 p. m. Aug. 1 for paving Buchanan and South sts. Bd. local impvts.

Salem, Ind.—Bids are asked until Aug. 6 for grading, macadamizing and draining High st. E. F. Routh, town clk.

Greencastle, Ind.—Bids are asked until Aug. 4 for building 2,600 ft. macadamized roads in Monroe twp. Bd. co. comrs.

Jasper, Ind.—Bids are asked until Aug. 6 for constructing 5 1-2 miles of macadam road in Columbia twp. Co. comrs.

Bloomington, Ind.—Bids are asked until Aug. 8 for constructing 4 gravel roads, aggregating 40,870 ft. Co. comrs.

Jacksonville, Fla.—Bids will be asked about Sept. 17 for paving Talleyrand ave. with vitrified brick. Cy. engr.

Cincinnati, O.—Bids are asked until Aug. 17 for improving Mitchell ave. Christian Bardes, prest. bd. co. comrs.

Denver, Colo.—Bids are asked until Aug. 1 for improving portions of wagon roads. T. W. Jaycox, state engr.

Cleveland, O.—Sealed bids are asked until Aug. 4 for completing the grading of Granger Hill. Julius C. Dorn, clk. co. comrs.

Brazil, Ind.—Sealed bids are asked until Aug. 7 for constructing a gravel road in Buren twp. J. Frank Smith, co. audt.

Decatur, Ind.—Bids are asked until Aug. 6 for building roadways in Hartford and French twps. L. L. Baumgartner, co. surv.

Batavia, O.—Bids are asked until Aug. 7 for constructing artificial stone sidewalks in sundry streets. G. H. Kain, vil. clk.

Amelia, O.—Sealed bids are asked until Aug. 11 for constructing artificial stone sidewalks on Main st. B. B. Cundiff, vil. clk.

Harrisburg, Pa.—Sealed bids are asked until Aug. 4 for constructing 673 ft. of road. Joseph W. Hunter, state highway comr.

Brookville, Ind.—Bids are asked until Aug. 6 for constructing macadam roads. Alfred L. Sayres, dir. freeholders; J. J. Albertson, co. engr.

Wabash, Ind.—Bids are asked until Aug. 27 for 40,000 sq. ft. of sidewalks on Manchester ave. and Walnut st. John Hilty, cy. engr.

National Soldiers' Home, Tenn.—Sealed bids are asked until Aug. 6 for constructing cement walks. Treas. Mountain Branch N. H. D. V. S.

Bloomfield, Ind.—Sealed bids are asked until Aug. 6 for constructing a gravel and mcadamized road in Washington twp. Wm. H. Deckard, co. audt.

Ravenna, O.—Sealed bids are asked until Aug. 7 for constructing a highway here under the new state law. Sam Huston, state highway comr., Columbus.

Warren, Pa.—Bids are asked until Aug. 2 for constructing a number of roads in this county. Jos. W. Hunter, state highway comr., Harrisburg.

Towanda, Pa.—Bids are asked until Aug. 2 for constructing 15,497 ft. of roads iin Wells twp. Jos. W. Hunter, state highway comr., Harrisburg.

Ebensburg, Pa.—Bids are asked until Aug. 4 for constructing 5,755 ft. of road in this borough. Jos. W. Hunter, state highway comr., Harrisburg.

Anamosa, Ia.—Bids are asked until Aug. 7 for 3,500 yds. of macadam paving and 1,200 ft. of curb and gutter, on 1st st. L. J. Fisher, cy. clk.

Washington, D. C.—Sealed bids are asked until Aug. 3 for paving various streets and avenues with sheet asphalt. H. B. F. MacFarland, chmn. Dist. Comrs.

Findlay, O.—Bids are asked until Aug. 1 for 15,000 sq. yds. of vitrified brick

paving on concrete base on Lincoln st. John W. S. Riegle, cy. engr.

Fennimore, Wis—Bids are asked until Aug. 6 for constructing about 25,000 sq. ft. of cement walks and 1,000 ft. of curb and gutter. Wm. W. Weaver, vil. clk.

Paulding, O.—Sealed bids are asked until Aug. 11 for paving Main st. with brick or macadam and crushed stone base, with curbing, etc. Ed. H. Cooper, vil. clk.

Leonia, N. J.—Bids are asked until Aug. 13 for constructing cement sidewalks on Park ave. and flag sidewalks on Spring st. H. M. Thompson, boro clk.

Pleasant Ridge, O.—Sealed bids are asked until Aug. 7 for grading, macadamizing, etc., Mooney ave., from Ridge to Kincaid aves. W. C. Davies, clk. coun.

Williamsport, O.—Bids are asked until Aug. 3 for grading and graveling, concrete curb and gutter and sidewalks on Ross ave. David H. Moffit, town clk.

Rockville, Ind.—Sealed bids are asked until Aug. 8 and 9 for constructing certain gravel roads. T. A. Garrard, chm. co. comrs.; Henry Grubb, co. audt.

Petersburg, Va.—Sealed bids are asked until Aug. 3 for furnishing and laying 8,000 to 10,000 sq. yds. of rubble stone paving on Old st. R. D. Budd, cy. engr.

Scottsburg, Ind.—Sealed bids are asked until Aug. 11 for constructing over 2 miles of free gravel road. Joseph H. Cortner, chm. co. comrs.; Frank Gardner, co. audt.

Martinsville, Ind.—Sealed bids are asked until Aug. 7 for constructing an extension to the Gregg twp. gravel road. Wm. E. Shuler, chm. co. comrs.; B. R. Johnson, co. audt.

Chehalis, Wash.—Bids are asked until Aug. 8 for covering about 9 miles of State road No. 5 with plank, gravel or crushed rock. W. A. H. Birley, chm. bd.; J. E. Stearns, co. audt.

Bedford, Ind.—Bids are asked until Aug. 7 for constructing gravel or macadamized roads in Guthrie, Flinn and Shawswick twp. Anselm Wood, chm. co. comrs.; Walter G. Owens, co. audt.

Independence, Kas.—Sealed bids are asked until Aug. 14 for 1,751 sq. yds. of brick paving; 8,500 cu. yds. excavation; 4,222 lin. ft. concrete curb and gutter. T. N. Sickles, cy. clk.

Mount Holly, N. J.—Sealed bids are asked until Aug. 13 for telfording a public road, 16,475 ft. in length, and macadamizing one 3.9 miles in length. Joel Horner, dir. freeholders.

Petersburg, Ind.—Sealed bids are asked until Aug. 7 for over 5 miles of gravel or macadamized roads in Washington twp. Wm. H. Gladish, chm. so. comrs.; Thos. W. Basinger, co. audt.

Crown Point, Ind.—Sealed bids are asked until Aug. 6 for building certain gravel roads in Winfield, Hobart, Cedar Creek and Ross twps. Samuel A. Love, chm. co. comrs.; Charles A. Johnson, co. audt.

Cincinnati, O.—Bids are asked until Aug. 8 for grading and setting curb on Belvare ave., and for grading, curbing and paving with brick Columbia ave. M. J. Keefe, clk. B. P. S.

Roselle Park, N. J.—Sealed bids are asked until Aug. 3 for constructing 1,670 ft. of 4 ft. stone flag sidewalk and 125 ft. stone crosswalk. J. Wallace Higgins, boro engr.; A. M. Woodruff, boro clk.

Salisbury, Md.—Bids are asked until Aug. 7 for 8,300 sq. yds. of vitrified brick paving, 2,400 ft. reinforced concrete curb, and 1,050 ft. 18 to 12 in. drains, with manholes, inlets, etc. Henry J. Byrd, clk. coun.

Memphis, Tenn.—Sealed bids are asked until Aug. 9 for paving Poplar st., from Manassas st. to Garland ave., with asphalt, and from Garland to Tucker aves. with gravel and macadam. J. T. Walsh, acting mayor; Ennis M. Douglass, cy. register.

Waukegan, Ill.—Sealed bids are asked until Aug. 1 for 5,500 sq. yds. of brick paving, and 1,700 sq. yds. of granite top macadam paving, with combination curb and gutter. Bids will be asked about Sept. 1 for 2 to 4 miles of cement walks. R. Miller, cy. engr.

East Chicago, Ind.—Bids are asked until Aug. 6 for paving Bloch, Pennsylvania and Commonwealth aves., and Washington, Guthrie and Cedar sts. with macadam, and 127th and Fir sts. with a pavement known as the "Westrumite Process." John J. Keenan, Jr., cy. clk.

Marietta, O.—Bids are asked until Aug. 4 for 13,600 sq. yds. of block paving. A. F. Cole, engr.

Cincinnati, O.—Bids are asked until Aug. 10 for paving Dayton st. with granite. M. J. Keefe, clk. B. P. S.

Symerton, Ill—Sealed bids are asked until Aug. 8 for 4,600 sq. ft. of concrete walks. L. H. Search, vil. clk.

Pleasant Ridge, O.—Bids are asked until Aug. 7 for grading and macadamizing Cypress ave. W. C. Raviess, clk.

Jacksonville, Fla.—Bids are asked until Aug. 8 for paving three-quarter mile of road with flint rock. F. J. Hyde, chm. co. comrs.

Portsmouth, O.—Bids are asked until Aug. 11 for grading, paving and curbing various streets. Chas. F. Schittmann, clk. B. P. S.

Princeton, Ind.—Sealed bids are asked until Aug. 6 for constructing 6 macadam roads. Jonathan W. Phillips, chm. co. comrs.; Harry R. Embree, co. audt.

Ottumwa, Ia.—Sealed bids are asked until Aug. 6 for paving Woodland ave. and Union st. with vitrified brick, with artificial stone curbing. W. H. O'Malley, chm. st. com.

Ft. Totten, N. Y.—Bids are asked until Aug. 6 for constructing about 9,649 ft. cement walk and 64 lin. ft. steps and risers at this post. George H. McManus, Constr. Q. M.

Buffalo, N. Y.—Bids are asked until Aug. 3 for constructing 3,999 sq. yds. of paving on Scoville ave., 3,334 sq. yds. on St. Joseph ave., and 3,890 sq. yds. on Stanislaus st. F. G. Ward, dir. pub. wks.

New York City—Bids are asked until Aug. 6 for repairing asphalt pavements in Manhattan borough. John F. Ahearn, prest. boro. Bids are asked until Aug. 1 for paving various streets in Brooklyn; Bird S. Coler, prest. boro. Bids are asked until Aug. 2 for excavating and grading with top soil the planting spaces on Prospect Park West, Brooklyn. Moses Herrman, prest. parks.

CONTRACTS AWARDED.

Bloomington, Ill.—The Barber Asphalt Paving Co. was awarded the contract for paving Filmore st.

Champaign, Ill.—Morrissey & Porter, of Paris, secured the contract for paving Clark st., for $16,556.

Westfield, N. J.—The contract for constructing flag sidewalks was awarded to Wm. H. Weldon, for $2,874.

Chillilcothe, Mo.—The contract for 38,000 sq. yds. of brick paving was awarded to M. Ford, of Cedar Rapids, Ia.

Quincy, O.—The contract for constructing cement paving was awarded to Robbins & McDaniel, of Springfield, for $2,000.

Cincinnati, O.—The contract for resurfacing Jackson st., between 12th and 13th sts., was awarded to Wm. Fogarty, for $2,978.

Cohoes, N. Y.—The contract for paving Ontario st. with brick was awarded to Mulderry Bros., of Albany, for $30,080.02.

Lake Charles, La.—A contract for 14 blocks of brick paving was awarded, July 13, to Pringle & Son, of Kansas City, for $73,000.

Elgin, Ill.—The Thomas J. Peter Co., of Chicago, secured the contracts for paving Spring, DePage and National sts., for $10,700.

Troy, N. Y.—T. Henry Dumary was awarded the contract for brick paving on Church st. and Franklin sts., at $2.19 a sq. yd.

Pendleton, Ore.—The contract for paving Main and Court sts. with bitulithic was awarded to the Warren Construction Co., of Portland.

St. Paul, Minn.—The contract for resurfacing E. 7th st., between Cedar and Pine, was awarded to the Barber Asphalt Paving Co., for $13,389.

East St. Louis, Ill.—Contracts for paving 15th st. with brick were awarded, July 12, to McCabe & Co., of this city, for $29,098.

Danville, Ill.—Bids were received, July 1, for paving the Batestown road, as follaws: Interurban Construction Co., $33,000; A. Cruzan, $35,200.

Delaware, O.—The contract for constructing the Harlem and Center Village road was awarded to Norris & Christian, of Marion, O., for $31,691.

New Orleans, La.—The contract for constructing concrete and plank walks at Jackson Barracks was awarded to Nyquist & Johnston, of St. Bernard.

Cresson, Pa.—The contract for constructing a section of state road in Cambria twp. was awarded to J. C. McSpadden, of Pittsburg, for $14,243.

Milwaukee, Wis.—The Barber Asphalt Paving Co. was awarded the contract for repaving the lower part of Grand ave. with asphalt, at $1.29 a sq. yd.

Piqua, O.—Jos. Small was awarded the contract for constructing sidewalks, curbs and gutters on Washington and Mound aves. and Weber st., for $3,005.64.

Hazleton, Pa.—A contract for 8,000 sq. yds. of Bitulithic has been awarded the Standard Bitulthic Company of New York.

Wichita, Kas.—The Kansas Bitulithic Company, of Kansas City, Mo., has been awarded a contract for 19,365 sq. yds. of Bitulithic.

Salisbury, N. C.—A contract for 25,000 sq. yds. has been awarded the Atlantic Bitulithic Company of Spartanburg, N. C.

Dallas, Tex.—The Texas Bitulithic Company has been awarded an additional contract for 15,000 sq. yds. of Bitulithic.

New Haven, Conn.—The city council has awarded to Warren Brothers Company, of Boston, a contract for 10,200 sq. yds. of Bitulithic.

Boston, Mass.—Warren Brothers Company, of Boston, will lay 4,300 sq. yds. of bitulithic in Huntington ave.

Portland, Ore.—The Warren Construction Company of Portland, Ore., have received a contract for 40,935 sq. yds. of Bitulithic.

Pueblo, Colo.—A contract for 24,348 sq. yds. of Bitulithic has been awarded the Warren Brothers Company of Boston.

Ann Arbor, Mich.—The Central Bitulithic Company, of Detroit, Mich., has received a contract for 10,000 sq. yds. of Bitulithic.

Pendleton, Ore.—A contract for 20,441 sq. yds. of Bitulithic has been awarded the Warren Construction Company, of Portland, Ore.

Shelbyville, Ind.—A contract for 41,391 sq. yds. Bitulithic has been awarded the Hoosier Construction Company, of Indianapolis, Ind.

St. Louis, Mo.—Additional contracts for 38,005 sq. yds. of Bitulithic have been awarded the Granite Bituminous Paving Company, of St. Louis.

Regina, Sask., Canada—The Warren Bituminous Paving Company, of Toronto, Ont., has been awarded a contract for 15,000 sq. yds. Bitulithic.

Perth Amboy, N. J.—The Standard Bitulithic Company, of New York, will construct 8,000 sq. yds. of Bitulithic.

Suffolk, Va.—A contract for 16,440 sq. yds. of Bitulithic has been awarded the Atlantic Bitulithic Company, of Spartanburg, N. C.

Cedar Rapids, Ia.—M. Ford submitted the lowest bid, July 20, for brick paving at $1.31 and $1.32 a sq. yd.

Dallas, Tex.—The contract for 47,000 sq. yds. of bitulithic paving was awarded July 5 to the Texas Bitulithic Co.

South Orange, N. J.—Donate Fusco, of Montclair, N. J., was awarded the contract for 1 mile of Telford paving, for $21,000.

Delaware, O.—The contract for constructing 7½ miles of road in Harlem twp. was awarded to Norris & Christian, for $16,691.

Kokomo, Ind.—The contract for asphalt paving on Walnut st. was awarded to the Union Asphalt Construction Co., of Indianapolis.

Seattle, Wash.—The Barber Asphalt Paving Co. was awarded the contract for paving Jackson st. from 1st ave. to Railroad ave., for $4,622.55.

Davenport, Ia.—The contract for constructing a large number of concrete sidewalks was awarded to Gust Ed & Sons, for $10,000.

Hagerstown, Md.—The contract for reconstructing Ringgold road, 3¼ miles in length, was awarded to C. H. Henson, of Harrisburg, for $19,617.

Ft. Smith, Ark.—The contract for constructing 65 miles of brick paving here was awarded, July 20, to Burke Bros. of St. Louis, for $601,225.

Centerville, Ia.—The contract for constructing about 2 miles of brick paving was awarded to the Davenport Construction Co., of Davenport, for $90,000.

Chenoa, Ill.—The contract for building cement sidewalks in the business part of the city was awarded to Rudolph S. Blome, of Chicago, for $10,000.

Aurora, Ill.—The contract for 14,663 sq. yds. of brick paving on S. Lake st. was awarded to J. A. Heineman, of Chicago, for $24,853. R. S. Safford, of this city, was awarded the contract for 8,260 lin. ft. of curb and gutter for $4,087.

Syracuse, N. Y.—The contract for paving Saratoga ave. with brick was awarded H. N. Cowles, for $43,235, and on Merrimac st., to Hagaman, Miller & Hagaman, for $1,874. F. A. Brotsch secured the contract for paving De Jonge st., for $5,733.

Harrisburg, Pa.—The Warner-Quinlan Paving Co., of Syracuse, N. Y., was awarded the contract for 31,223 sq. yds.

of paving, July 20, at $1.70 to $1.75 a sq. yd. The Barber Asphalt Paving Co. was awarded the contract for paving 18th st., at $1.71, and Watts alley at $1.81⅛ a sq. yd.

Chatham, Ont.—The Warren Bituminous Paving Company, of Toronto, Ont., has received a contract for 4,834 sq. yds. of Bitulithic.

Celina, O.—The contract for paving W. Market st. was awarded to E. A. Freshwater & Sons, of Chester, W. Va., for $23,000. Athens brick will be used.

Marinette, Wis.—The contract for paving four streets with macadam, with brick gutters and and brick crosswalks, was awarded to J. P. Delaney, for $28,000.

St. Joseph, Mo.—Paving contracts were awarded, July 12, to Rackliffe & Gibson, and the Phoenix Brick and Construction Co. Brick will be used.

Alliance, O.—J. C. Devine was awarded a contract for paving Patterson st. with Malvern block, and John Wilson, the contract for paving Ely st. with Minerva brick.

Centerville, Ia.—The contract for brick paving was awarded to the Davenport Construction Co., of Davenport, at $1.78½ a sq. yd. for paving, and 44 cts. a ft. for curb.

Bellevue, Pa.—The contract for 6,952 sq. yds. of brick paving, 4,600 lin. ft. curb, and 8,000 cu. yds. exca., was awarded to Sam Gamble, of Carnegie, Pa., for $29,228.

Fond du Lac, Wis.—The contract for asphat paving on Sheboygan st. was awarded to the Barber Asphalt Paving Co., at $1.75 a sq. yd., and 50 cts. a lin. ft. for curb and gutter.

Baltimore, Md.—The contract for constructing a highway between this city and Washington was awarded to John F. Killeen, of Washington. About 28 miles of road will be constructed.

Galena, Ill.—John Bastian was awarded the contract for 2,740 sq. yds. of brick paving, at $1.60 a sq. yd., and the contract for curbing was awarded to Walter Slattery.

Montgomery, Ala.—The contract for paving Sayre st. with asphalt was awarded to the Memphis Asphalt Paving Co., and for paving Hull st. with brick, to the Chattanooga Roofing and Paving Co.

Meadville, Pa.—Paving contracts were awarded, July 9, as follows: Water st., brick, Marquis & Wallace; South Park ave., asphalt block, International Construction Co.; Market st., Marquis & Wallace.

Perth Amboy, N. J.—Bids were submitted in July for constructing five new stone roads, John Hurley, of Trenton, being the lowest bidder on four, and Ned Lawrence, of Metuchen, the lowest on one of the roads.

London, Ont.—The contract for paving King st., from Wellington to Maitland sts., with Kentucky rock asphalt, was awarded, July 9, to Blight & Fielder, of Chatham, at $1.05 a sq. yd., 5-yr. guaranty.

Salt Lake City, Utah—Special. Contract for 15,000 sq. yds. of macadam paving on First st., from A to J, and 47,000 sq. yds. on Second and C sts., was awarded, July 2, to P. J. Moran, for $24,974 and $79,199, respectively.

Altoona, Pa.—The Gant Construction Co., of Canton, O., was awarded the contract for 142,576 sq. yds. of paving, for $253,567, and the American Asphaltum and Rubber Co., of Chicago, the contract for asphalt filler for $29,228.

Rock Island, Ill.—The contract for asphalt paving on 19th st. was awarded July 14, to the T. J. Peters Co., of Chicago, at $1.95 a sq. yd.; 60 cents a lin. ft. for curb; 40 cents a cu. yd. for exca.; $2.75 a ft. for 24 in. tile; $35 each for catchbasins.

Boston, Mass.—Contracts for constructing state roads have been awarded as follows: Garden, Fred E. Ellis, of Melrose, $4,195; Charlton, R. F. Hudson, of Melrose, $4,196; Ashby, R. F. Hudson, of Melrose, $3,237; Hadley, Lane Construction Co., $3,120.

Milwaukee, Wis.—The Barber Asphalt Paving Co. was awarded the contract for paving National ave., from 21st to 17th aves., with asphalt, at $2.08 a sq. yd. Wm. Gutnecht was awarded a contract for brick paving on State st., at $1.89, and the Badger Const. Co., a contract for brick paving on Farwell ave., at $2.19 a sq. yd.

Fargo, N. D.—The contract for paving N. Broadway, from the G. N. tracks to 12th ave., north, with creosoted wood blocks on concrete base, was awarded, July 16, to Jas. Kennedy, at $2.91 a sq. yd., 96 cents a lin. ft. for Kettle River sandstone curbing, 60 cents a cu. yd. for exca., $63 each for catchbasins, $63 each for gutter basins, $57 each for manholes, and $9 each for castings.

Janesville, Wis.—The contract for paving River st. and Postoffice alley was awarded, July 20, to A. E. Rutledge & Co., of Rockford, Ill., as follows: River st., brick paving, $1.53 a sq. yd.; stone curbing, 50 cents a lin. ft.; curb reset, 20 cents; protection curb, 40 cents; protection curb reset, 20 cents; c. i. plates, $7.50 each; total, $6,124.24. Postoffice Alley, brick paving, $61.62; protection curb, 10 cents; total, $1,564.43.

Muscatine, Ia.—Special. James J. Ryan, cy. engr., advises us that a contract for brick paving on 8 in. sand foundation in impvt. dist. No. 23, was awarded, July 2, to R. K. Smith and McCarthy Improvement Co., of this city, as follows: 28,220 cu. yds. exca., 31 cents.; 42,332 sq. yds. brick paving, $1.49; 17,650 lin. ft. 5x20 in. curbing, 58½ cents; 6,600 ft. 5x16 in. curbing, 53¼ cents; extra gravel, $1; total, $85,679.13.

Albany, N. Y.—Contracts for improving public highways were awarded, June 28, 29 and 30, to Casey & Murray, 313 Powers Bldg., Rochester; Corliss Constr. Co., Troy; D. V. Ashley, Binghamton; Andrews Bros., Mineola; Wm. E. Baldwin & Co., 666 Ellicott Square, Buffalo; Clinton Beckwith, Herkimer; F. A. Brotsch, Powers Bldg., Rochester; Brayer Bros., Auburn; Brennan & O'Brien, Watertown. Board of Supervisors of Erie Co.; Mosier & Summers, 1266 Seneca st., Buffalo; Mott & Kemper, 75 Arcade Bldg., Utica; James E. Martin, Poughkeepsie; McName & Rice, Rondout; J. H. Nelson & Co., Herkimer; Orange Co. Road Constr. Co., 120 Broadway, New York City; J. W. Polcaro, Pittsfield, Mass.; C. H. Quereau, Baldwinsville, N. Y.; S. A. Seymour, Herkimer; Schenectady Contracting Co., Schenectady; Robert Shafer, Albany; Henry C. Schroeder, Henrietta st., Rochester; D. I. Snell & Co., Canajoharie; Saratoga Trap Rock Co., Saratoga; A. Schaupp, Albany; U. G. Stockwell, Albany; Siver & Gould, Sidney; E. R. Steele, Herkimer; W. I. Tyler, Chittenango. Town of Rochester, N. Y.; S. B. Van Wagonen, Rondout. Town Board of Lloyd; John Weber & Sons, New York City; Joseph Walker, Mariners' Harbor; C. C. Burns, Watertown; Bouvier

& Rawlins, Elmira; Buckley Constr. Co., Plattsburg. Bd. of Supervisors, Broome County; Chambers & Grady, 315 Powers Bldg., Rochester; John F. Consaulus, West Brighton, S. I., N. Y.; J. C. Dayton, Auburn; W. J. Dwyer, Syracuse; John Flynn, Waterford; J. T. Finch, Glens Falls; Ferguson Bros., Fishers Island; Gantz-Wilson Co., Buffalo; General Construction Co., Bridgeport, Conn.; John H. Gordon, Albany; Greece Constr. Co., Powers Bldg., Rochester; F. W. Hamilton, Rochester; Scofield Co., Penn Bldg., Philadelphia, Pa.; John Johnson, Buffalo; F. W. Knickerberg, Buffalo; Thomas H. Karr, Troy; Lane Constr. Co., Meriden, Conn.; C. R. Lewis, Ilion; Nicholas Marnell, Syracuse; D. Moynehan, Utica; B. Manion, Herkimer; M. Murray, Troy; J. H. Malcolm, Albany.

SEWERS.

Rockville, Conn.—The Bunting Construction Co. have about completed the construction of sewage filter beds in this city and they will probably be put in operation about Aug. 1.

Columbus, O.—Messrs. Fred J. Immel, Fred Lied and Chas. B. Burr, of the B. P. S., and Henry Maetzel, chief engineer, visited Jackson July 10, to inspect a new type of sewer pipe, with a view to introducing it in this city. The pipe is made of cement and is constructed alongside the trench where it is to be laid on the system of the Reinforced Concrete Pipe Co., of Jackson, Mich.

CONTEMPLATED WORK.

Pinole, Cal.—A sewerage system is contemplated.

Ida Grove, Ia.—A number of sewers are proposed.

Lewiston, Mont.—The construction of two new sewers is contemplated.

Woodstock, Ill.—The construction of a sewerage system is proposed.

Elm Grove, Tenn.—This city voted $3,500 for constructing sewers.

Stewartsville, Minn.—Plans have been prepared for eight blocks of sewers.

Independence, Mo.—The extension of the sewerage system is contemplated.

Ada, I. T.—The question of installing a sewerage system is being discussed.

Red Wing, Minn.—Council is considering the construction of sewer extensions.

Sedro-Woolley, Wash.—The construc templated.

Aberdeen, S. D.—Plans for a pump house for the sewerage system have been completed.

Rapid City, S. D.—This city voted to issue $40,000 for constructing a sewerage system.

Webster Groves, Mo.—The establishment of a sewerage system is contemplated. S. Hart, mayor.

Decatur, Ill.—The question of issuing $44,000 water and sewer bonds will be vated on Aug. 14.

Waynesboro, Pa.—A 4-ft. concrete and stone sewer will be constructed under the Center Square.

Durand, Mich.—Bids will be asked soon for building three-quarter mile of sewers. F. L. Eldridge, cy. clk.

Muskegon, Mich.—The construction of 11 miles of sewers is contemplated. C. S. Gamble, cy, engr.

Jackson, Mich.—Bids will be asked for soon for building 1,800 ft. of 3-ft. reinforced concrete sewer.

Trenton, N. J.—An ordinance has been passed providing for the installation of sewers in various streets.

Evanston, Ill.—An ordinance has been passed providing for a sewer in Central st. Prest. bd. local impvts.

Billings, Mont.—Council is considering the construction of a sewer at a cost of $33,000.

Lancaster, N. Y.—The construction of a sewerage system is contemplated. Plans and specifications have been made.

Owosso, Mich.—Bids will be asked for this fall for building 4,200 ft. of 24-in. sewer. E. S. Brewer, cy. engr.

Houghton, Mich.—Specifications and profiles have been completed for constructing the new West Houghton sewer system.

Livingston, Mont.—The question of issuing $25,000 bonds for building a main sewer will be voted on Aug. 14.

Oelwein, Ia.—A resolution has been adopted for constructing additional sewers. Wm. A. Reed, mayor; R. E. Bales, cy. clk.

Charles City, Pa.—City council has decided to expend several thousand dollars in constructing a complete sewerage system.

Newton, N. C.—This town will expend $50,000 in the construction of waterworks and sewerage systems. John P. Young, men. com.

New Haven, Conn.—Plans have been completed for constructing an overflow sewer at a cost of about $40,000. C. W. Kelly, cy. engr.

New Wilmington, Pa.—Surveys and plans for the proposed new sewerage system for this town will be made by Geo. B. Zanizer, C. E., of New Castle.

San Francisco, Cal.—Notice of intenton has been given to expend about $30,000 for repairing sewers and pavements. Thos. P. Woodward, cy, engr.

Mingo, O.—A contract for making maps and estimates for a complete sewerage system has been awarded to the Williams Engineering Co., of Steubenville.

Lake Forest, Ill.—An ordinance has been passed providing for the construction of sewers, manholes, flush connections and house connection slants. Cy. clk.

Oakland, Cal.—A petition will be submitted to council asking that the question of issuing $585,000 bonds for the construction of a new outfall system be voted on.

Little Rock, Ark.—The question of establishing sewer dist. No. 43 in the southeastern part of the city is under consideration. Estimated cost, with septic tank, $20,000.

Charleston, S. C.—The sewerage plans for extending the sewerage system are being revised by J. H. Dingle, cy. engr., and J. L. Ludlow, of Winston, N. C. The work covers 47¼ miles of 8 to 22-in. pipe.

Elmwood Place, O.—Plans are being prepared for the proposed sewerage system.

Gardner, Mass.—The sewer comrs. desire an additional appropriation for the extension of the sewerage system in West, Kendall and Glenwood sts.

Milford, Mass.—At a special town meeting held July 20, the Milford sewer act was accepted and $50,000 appropriated to begin the work of construction.

Mount Gretna, Pa.—Geo. W. Haves, of Lebanon, Pa., has been engaged to super-

intend the enlargement of the sewage disposal works for the Pennsylania Chautauqua.

CONTRACTS TO BE LET.

Burlington, Ia.—Bids are asked until Aug. 6 for constructing a 10-in. sewer. Cy. clk.

Iowa Falls, Ia.—Bids are asked until Aug. 27 for constructing 5 blocks of sewers. F. E. Foster, cy. clk.

Brewster, Minn.—Bids are asked until Aug. 6 for constructing 6,355 ft. of drains. Otto Knuth, vil. recdr.

Cleveland, O.—Bids are asked until Aug. 4 for constructing a concrete culvert. Wm. H. Evers, co. engr.

Sayre, Pa.—Bids are asked until Aug. 15 for constructing a trunk line sewer. H. H. Morcereau, boro clk.

Grand Forks, N. D.—Bids are asked until Aug. 6 for constructing a lateral sewer. W. V O'Connor, cy. audt.

Seneca Falls, N. Y.—Bids are asked until Aug. 11 for constructing a sewerage system. E. L. Guion, vil. clk.

Polo, Ill.—Bids are asked until Aug. 30 for building 8 to 16-in. sanitary sewers. J. A. Davidson, cy. engr.

Washington, D. C.—Bids are asked until Aug. 6 for building pipe sewers. H. B. F. MacFarland, chm. Dist. comrs.

Valley City, N. D.—Bids are asked until Aug. 6 for building 560 ft. of 10-in. sewer. W. T. Craswell, cy. audt.

Rockwell City, Ia.—Sealed bids are asked until Aug. 6 for constructing sewers in an alley and First st. V. N. Noel, mayor.

Carroll, Ia.—Bids are asked until Aug. 2 for building 2 miles of 8 to 18-in. sewers, with sub-drains, manholes, etc. H. M. Hansen, cy. engr.

Evanston, Wyo.—Bids are asked until Aug. 6 for constructing 3,700 ft. 15, 3,020 ft. 12, 300 ft. 8, 6,300 ft. 6 in. tile pipe sewer; 31 brick manholes complete. Wm. Cook, town clk.

Bemidji, Minn.—Sealed bids are asked until Aug. 6 for constructing a sewerage system consisting of 1,,900 rt. 18-in., and 2,700 ft. 8 to 12-in. sewer pipe. M. D. Stoner, cy engr.; Thos. Holey, cy. clk.

Boston, Mass.—Sealed bids are asked until Aug. 3 for constructing section 64, Malden extension, of the North Metropolitan sewerage system, located in Malden. Henry H. Sprague, chm. Met. water and sewerage bd.

Manila, P. I.—Sealed bids are asked until Sept. 12 for furnishing and delivering sewer gates and sluice gates for use in the proopsed sewerage system. J. F. Case, ch. engr. Municipal Board, Manila, or Bureau of Insular Affairs, Washington, D. C.

Ogden, Utah—Sealed bids are asked until Aug. 4 (ready) for constructing 1,150 lin. ft. 6-in., 20,025 ft. 8-in., 4,572 ft. 10-in., 1,913 ft. 12-in., 1,938 ft. 15-in., 1,531 ft. 18-in., 1,732 ft. 21-in., and 3,042 ft. 24-in. sewers with 116 brick or concrete block manholes complete. A. F. Parker, cy. engr.

Janesville, Wis.—Sealed bids are asked until Aug. 10 for constructing 2,124 ft. sewer in dist. No. 5; 3,529 ft. in dist. 6; 1,998 ft. in dists. 10 and 11; 1,744 ft. in dist. No. 12; 1,143 ft. in dist. No. 14; 1,238 ft. in dist. No. 15. J. F. Hutchinson, chm. st. ass'mt. com.

Polo, Ill.—Bids are asked until Aug. 30 for building sanitary sewers. J. A. Davidson, cy. engr.

North Platte, Neb.—Bids are asked until Aug. 14 for constructing sewer laterals in dists. I and L. Cy. clk.

Owensboro, Ky.—Bids are asked until Aug. 6 for constructing a sewer on Main st. leading to Lead creek. Cy. coun.

Evanston, Ill.—Bids are asked until Aug. 2 for constructing a sewer in Lake st. John T. Barker, prest. bd. local impvts.

Claremore, I. T.—Bids are asked until Aug. 9 for constructing a sewerage system. W. P. Bullock, engr., 110 Monroe ave., Kansas City, Mo.

Carroll, Ia.—Bids are asked until Aug. 2 for constructing 2 miles of sewers with sub-drains, manholes, etc. H. M. Hansson, cy. engr.

Chester, Pa.—Sealed bids are asked until Aug. 6 for constructing sewers on Barclay and Wilson sts. Samuel McClure, chm. sewer com.; Frank W. Harrison, cy. clk.

Lewiston, Idaho—Bids are asked until Aug. 8 for constructing pipe, concrete or brick sewers, 86 manholes and 47 flush tanks. D. C. Wrighter, cy. engr.; John E. Nickerson, cy. clk.

CONTRACTS AWARDED.

Waterbury, Mass.—The contract for excavating soil and paving bank of Neugatuck river for the Waterbury sewage disposal works was awarded to Auguste Saucier, of South Framingham, for $52,050.

Bellevue, Ky.—The contract for constructing sewers was awarded to J. H. McLane & Co., of Newport, for $58,816.

Hutchinson, Kas.—Davis & Heizer secured the contract for constructing a storm sewer on Elm st., for $7,303.77.

Fairbury, Neb.—The contract for building a sewer was awarded to A. A. Lang, of University Place, Neb., for $5,853.

Seattle, Wash.—The contract for constructing the North Capitol Hill subsewer was awarded to T. Ryan, for $34,-795.85.

Boone, Ia.—The Christy Constr. Co. was awarded the contract for building 8,000 ft. of sewers here for $12,320.

Marianna, Ark.—The contract for constructing a sewerage system in dist. No. 1 was awarded to Nick Peay, for $21,000.

Madison, Wis.—J. H. Mitchell, city, secured the contract for building 2½ miles of sewers in Sherman ave dist., for $14,000.

Grand Rapids, Mich.—The contract for constructing the Southeastern sewer was awarded to Thomas J. Peters, of Chicago, for $97,800.

Edmonton, Alta.—Contracts for sewer and water extensions were awarded, July 10, to Taylor, Bouchier & Peters, for more than $200,000.

Moorhead, Minn.—James Kennedy, of Fargo, N. D., secured the contract for constructing a sewerage system in this city, for $88,980.

Pensacola, Fla.—The contract for constructing a sewerage system here was awarded, July 9, to H. K. Storrie, of New Orleans, for $307,000.

Utica, N. Y.—James W. Johnson was awarded the contract for building a storm water sewer system in W. James and other streets, for $29,816.

Wadsworth, O.—The contract for constructing 7,305 ft. of sewers, 35 manholes, etc., was awarded to Spangler & Skeels, of Canton, O., for $6,352.

Danville, Ill.—A. Cruzan was awarded the contract for building a sewer in an alley at 69 cents a lin. ft. for sewer, $30 each for manholes, $30 each for flush tanks.

McPherson, Kas.—Special. H. A. Row-

land, cy. engr., advises us that the contract for constructing 8, 10, 12 and 15-in. pipe sewers, 10 manholes and 14 receiving basins in sub-district was awarded, July 2, to Peter Wingerter, of this city, for $3,786.55.

Crystal Falls, Mich.—Special. E. G. Bradbury, engr., Columbus, O., advises us that the contract for constructing a sewerage system in dist. No. 2 was awarded, July 16, to Anton Harkman, of Green Bay, Wis., for $22,988.04. Other bids received were: Chris Johnson, Oshkosh, $29,776.67; Jas. Byers & Co., Houghton, Mich., $41,579.78; Harding & Nelson, Racine, Wis., $48,291.41; Green & Sons, Appleton, Wis., informal bid, $28,506.70.

Philadelphia, Pa.—Contracts for construction and extension of main sewers in different sections of the city were awarded, July 18, as follows: Exten. Jackson st. sewer, Joseph Perna, $42,370; exten. Rising Sun ave. sewer, Richard P. Bennis, $14,323.40; Frankford intercepting system, Howard E. Ruch, $45,841.22; Cresheim Creek intercepting sewer, David McMahon, $17,025.80; exten. Whitaker ave. sewer, David McMahon, $24,949.70; reconstruction sewer on Market st., Robert J. Ryan, $22,350.90; exten. Wissahickon high level intercepting sewer, Richard P. Bennis, $72,504.

WATER WORKS.

New York City—The Pneumatic Water Works and Construction Co. has been incorporated by Harold Hayson, J. S. Carleson and M. C. Heine, of this city.

Asheville, N. C.—The Buckeye Water Co. has been incorporated by R. P. Hayes, L. P. Hayes and J. C. Martin.

CONTEMPLATED WORK.

Cooleemee, N. C.—Surveys for a water works system have been made.

Red Wing, Minn.—Council will secure prices for a sand filtering plant.

Marion, Ind.—The extension of the water mains to South Marion is proposed.

Waycross, Ga.—Voted issue bonds for extension of the water works system.

Wauseon, O.—Voted to issue $2,000 bonds for improving the water works system.

Grand Junction, Colo.—The question of issuing water works bonds will be voted on Aug. 1.

McComb City, Miss.—This city will vote, Aug. 4, on the issue of $15,000 to extend the water mains.

Seattle, Wash.—Surveys for the proposed new Cedar river pipe line will be completed about Aug. 15.

Toccoa, Ga.—Plans have been completed for a gravity water works system. W. A. Matheson, chm. w. w. com.

Niagara Falls, N. Y.—The installation of a new electric pump at the city pumping station is contemplated.

Fairbury, Neb.—City council passed an ordinance to issue $6,000 bonds for purchase of a new pump or repair of old one.

Portsmouth, O.—This city is considering the question of securing a better water supply and constructing a filtration plant.

Springfield, Ill.—The city engineer has been directed to prepare plans and specifications for the proposed new dam at the water works.

Lockport, N. Y.—Plans and specifications have been submitted and bids will be asked for a municipal water supply from Niagara river.

Spokane, Wash.—A hearing will be given, Aug. 3, to the proposition of F. S. Barrett for a franchise to lay water mains in four additions.

Chambersburg, Pa.—The Cumberland Valley R. R. Co. has offered this city $50,000 to be applied to the construction of a water works system.

White Salmon, Wash.—The White Salmon Water, Light and Power Co. has been incorporated to establish water works and electric light systems.

Hamilton, O.—The question of issuing $225,000 bonds for enlarging and improving the water, gas and electric light plants will be voted on in August.

New York City—Bids will be asked at once for a new reservoir in the Croton watershed, to have a capacity of 16,000,000,000 gallons. Aqueduct com'n.

Nunda, N. Y.—The citizens have petitioned for a special election submitting to the taxpayers the question of the purchase of the waterworks plant.

Allegheny, Pa.—Plans are being prepared for improving the water supply by the construction of a basin of 2,000,000 gallons capacity in the vicinity of Aspinwall.

Nashville, Tenn.—W. W. Southgate, cy. engr., and other members of the city engineering department, are preparing plans for a supplementary water works system.

Buffalo, N. Y.—Plans for the inlet pier and tunnel, part of the proposed new water works system, have been placed on file in Mayor Adams's office. Bids will be asked for soon.

The construction of water works systems is contemplated at the following places: Cloquet, Minn.; Bunkie, La.; Newton, N. C., John P. Yount, mayor; West Branch, Ia.; Stevensville, Mont.; Murphy, N. C.

Louisville, Ky.—Bd. of water works trustees adopted the report of the special committee on a filter plant and will recommend an appropriation of $250,000 to build another pump, according to press reports.

Vicksburg, Miss.—The organization of a company to establish water works is proposed, and a committee has been appointed to engage an engineer to make surveys and estimates. J. P. Adams, secy. Business League.

The question of issuing water works bonds for the construction of water works has been favorably voted on at the following places: Claremore, I. T.; Tulsa, I. T.; Cold Spring, Minn.; Scribner, Neb.; Mite City, La.; Clinton, Ill.; Caney, Kas.; Steelton, Ont.; Madill, I. T.; Vale, Ore.; Big Timber, Mont.

Trenton, N. Y.—A water works system is contemplated.

Wauseon, O.—Voted to issue $20,000 bonds for improvements of waterworks.

Osyka, Miss.—Voted to issue bonds for the construction of a water works system.

Carberry, Man.—This town will need material for constructing a complete water works system, according to press reports.

Peoria Heights, Ill.—This village will build a new pumping station at the Tonty and lay new mains. Jacob Harmon, engr.

Grand Rapids, Mich.—L. W. Anderson, cy. engr., is engaged in devising a plan for improving the water works system throughout the city.

Salt Lake City, Utah—The canal companies using the waters of Utah Lake voted, July 16, to install another pump at

the pumphouse near Lehi. The Salt Lake City Canal Co., Utah and Salt Lake Canal Co., East Jordan Irrigation Co., South Jordan Canal Co., and North Jordan Canal Co., are interested.

CONTRACTS TO BE LET.

Britton, S. D.—Bids are asked until Aug. 6 for drilling an artesian well. M. S. Woodward, co. audt.

Rockwell City, Ia.—Bids are asked until Aug. 6 for constructing a water main. V. N. Noel, mayor.

Garrettsville, O.—Sealed bids are asked until Aug. 3 for furnishing and laying pipe. Bd. trustees.

Otterbein, Ind.—Bids are asked until Aug. 8 for constructing a water works system. L. E. McDonald, cy. clk.

Kingsley, Mich.—Bids are asked until Aug. 2 for constructing a water works system . L. E. McDonald, cy. clk.

Bloomington, Ill.—Bids are asked until Aug. 3 for furnishing and laying water pipe, etc. Bd. local impvts.

Spooner, Wis.—Bids are asked until Aug. 9 for laying 1,140 ft. 6 and 2,440 ft. 4-in. water mains. L. J. Thompson, vil. clk.

Nashville, Tenn.—Sealed bids are asked until Aug. 16 for furnishing and erecting a pumping engine. John T. Ahearn, supt. w. w.

Washington, D. C.—Bids are asked until Aug. 4 for furnishing 600 tons of 8-in. c. i. pipe. H. B. F. MacFarland, chm. Dist. comrs.

Chicago, Ill.—Sealed bids are asked until Aug. 10 for furnishing and delivering gate valves at the various pumping stations. Wm. L. O'Connell, comr. pub. wks.

Trinidad, Colo.—Bids are asked until Aug. 6 for laying 24 miles of 13, 15 and 16-in. steel pipe to supply this city with water from a mountain stream. I. D. Miliken, cy. clk.

Ft. Snelling, Minn.—Bids are asked until Aug. 9 for constructing an addition to the pump house and furnishing boiler and feed water heater and steel tank and trestle. Jos. Vogt, vil. recdr.

Aurora, Minn.—Sealed bids are asked until Aug. 7 for the purchase of 3,700 ft. 6-in. c. i. water pipe; 150 ft. 4-in. c. i. pipe; 8 hydrants, tees, crosses, valves, etc. F. V. Anderson, mem. vil. com.

New Orleans, La.—Sealed bids are asked until Sept. 5 for furnishing and erecting two complete water purification plants, including excavations, foundations, concrete masonry, reservoirs and filters, etc. F. S. Shields, secy. sewerage and water bd.

Malta, O.—Bids are asked until Sept. 4 for constructing a pipe system for the water works. B. P. W.

San Jose, Cal.—Bids are asked until Aug. 7 for constructing a pumping station. Henry A. Pfister, clk. bd. supvrs.

Wellsville, O.—Bids are asked until Aug. 3 for constructing 600 feet of 20-in. c. i. inflow. C. R. Macgregor, clk. B. P. S.

Philadelphia, Pa.—Bids are asked until Aug. 8 for water pipe, stop valves, trenching and laying pipe. Thos. L. Hicks, dir. pub. wks.

Evanston, Ill.—Sealed bids are asked until Aug. 2 for laying a 6-in. water main on Lake st. and Pitner ave. John T. Barker, prest. bd. local impvts.

Wilmington, Del.—Bids are asked until Aug. 13 for constructing and erecting a preliminary filter, reservoir and house. Theodore A. Leisen, ch. engr.

Portsmouth, N. H.—Bids are asked until Aug. 14 for installing 2 centrifugal pumps at the navy yard. Bureau of Supplies and Accounts, Washington, D. C.

Fort Terry, N. Y.—Bids are asked until Aug. 8 for constructing an extension to the water distributing system at Ft. Terry, Plum Island. Lieut. R. I. McKenney, constr. Q. M.

Galveston, Tex.—Bids are asked until Aug. 30 for furnishing 4 water tube boilers, constructing 1 brick chimney and concrete steel or steel stack for the water works and electric light plant. J. A. B. Miller, prest. cy. comrs.

Croton Falls, N. Y.—Bids are asked until Aug. 7 for constructing a reservoir, including a large masonry dam across the west branch of Croton river, and an earth diverting dam across east branch of Croton river, and an open connecting channel. John F. Cowan, prest. Aqueduct Comn.

Pipestone, Minn.—Will C. Fraser was awarded the contract for building 3 miles of sewer, for $13,500.

Knoxville, Tenn.—The contract for building the North Knoxville sewer was awarded, July 26, to Chas. T. Heins, for $16,000.

Nashville, Tenn.—The contract for constructing Pugley's branch trunk sewer was awarded, July 21, to P. M. Warden, for $13,694.25.

Ft. Smith, Ark.—The contract for constructing 44 miles of sewers was awarded, July 20, to W. J. Gawne & Co., of Cincinnati, for $471,434.25.

CONTRACTS AWARDED.

Edmonton, Alta.—The contract for constructing water mains was awarded to Shannon & Graham, for $11,335.

Leesburg, Va.—W. G. Morris, of Phoebus, Va, was awarded the contract for constructing a water works system.

Potlatch, Wash.—The contract for constructing a water works system was awarded to James Broad, of Spokane, for $8,000.

Laurinburg, N. C.—The Southern Contracting Co. was awarded a contract for constructing a water works system here for $34,000.

Columbus, O.—Westwater & Casey, of this city, submitted the lowest bid, July 18, $204,817.30, and will probably be awarded the contract.

Berkley, W. Va.—Dr. H. L .Kirkpatrick, J. E. Garrett, Alex McNabb and associates have been granted a franchise for installing water works here.

East McKeesport, Pa.—The contract for constructing a large reservoir for the East McKeesport Water Co. was awarded to Hastings & Barrett, of Wilmerding, for $14,000.

Wanette, Okla.—Water works contracts were awarded here, July 5, as follows: Hydrants and valves, Fairbanks Co.; pumps, McGowan Pump Co.; boilers, Atlas Engine Co.; construction work, O'Neill Engineering Co., of Dallas, Tex.

Casey, Ill.—A contract has been awarded to the Chicago Bridge and Iron Works for building a standpipe for $6,600, and the contract for mains and plugs and laying pipe was awarded to the Byrne Construction Co., of St. Louis, Mo., for $7,400.

BRIDGES.

Sangerville, Me.—This town voted $5,000 for erecting a steel bridge.

Tipton, Ind.—Bids are asked until

Aug. 6 for building 2 bridges. Co. comrs.

Cleveland, O.—Bids are asked until Aug. 4 for constructing a concrete culvert. J. C. Dorn, clk.

Covington, Ind.—Bids are asked until Aug. 10 for constructing a viaduct. Jas. T. Bell, co. audt.

Wabash, Ind.—Bids are asked until Aug. 6 for constructing an 80-ft. concrete arch. Co. comrs.

Vincennes, Ind.—Bids are asked until Aug. 7 for building 3 steel bridges. John T. Scott, co. audt.

Tiffin, O.—The county comrs. have approved plans and specifications for a river bridge in section 25.

Portsmouth, O.—Bids are asked until Aug. 17 for constructing 3 iron bridges. F. N. Fynes, co. audt.

Rushville, Ind.—Bids are asked until Aug. 6 for constructing 2 concrete arches. A. L. Stewart, co. engr.

Nevada, Mo.—Bids are asked until Aug. 10 for constructing 3 steel bridges. Jas. M. Clack, rd. and bridge comr.

Danville, Ind.—Bids are asked until Aug. 6 for constructing a bridge in Center twp. D. D. Mills, co. audt.

Topeka, Kas.—Bids are asked until Auk. 13 for constructing 2 steel bridges across Kansas river. M Snattinger, co. clk.

Omaha, Neb.—Sealed bids are asked until Aug. 11 for making repairs and erecting pile bridges. D. M. Haverly, co. clk.

Salem, Mass.—The contract for erecting a concrete and granite bridge across Miles river was awarded to E. A. Abbott, of Boston.

Wellington, Kas.—Sealed bids are asked until Aug. 6 for constructing 1 steel bridge across Elm creek in London twp. C. B. Macdonald, co. clk.

Olympia, Wash.—Bids are asked until Aug. 6 for constructing 2 Pratt truss combination bridges on stone piers. Okanogan co. comrs.

Lexington, Miss.—Bids are asked until Aug. 6 for making repairs to the iron bridge over Tchula Lake at Tchula. P. Williams, co. clk.

Winnipeg, Man.—The city engineer, H. N. Ruttan, has been directed to prepare plans for a bridge over Red River at the foot of McDermot ave.

Fortress Monroe, Va.—Bids are asked until Aug. 11 for reconstruction of bridges leading into Fort Monroe. Capt. R. H. C. Kelton, Constr. Q. M.

Newton, Mass.—Bids are asked until Aug. 7 for building a reinforced concrete and pile bridge over Charles river here. Irving T. Farnham, cy. engr.

Indianapolis, Ind.—Sealed bids are asked until Aug. 2 for building bridges over Indian and Crooked creeks. Thos. E. Spafford, chm. co. comrs.

Moncton, N. B.—Bids are asked until Aug. 6 for erecting the metal superstructure of Halls creek bridge. C. H. La Ballois, dept. pub. wks., Fredericton.

Kutztown, Pa.—The Reading Ry. Co. contemplates the construction of a steel trestle 120 ft. long for the Allentown & Reading Traction Co.

Jefferson, O.—Bids are asked until Aug. 6 for constructing concrete masonry abutments and driving piles on Grand river on the road leading from Rome Center.

Sidney, O.—County comrs. have authorized the sale of bonds for the construction of a bridge across the Miami river, in the southern part of this city.

Lyons, La.—Bids are asked until Aug. 4 for constructing a steel approach for highway and street car service here. J. A. Nottinger, secy. Lyons & Fulton Bridge Co.

Bay City, Mich.—Sealed bids are asked until Aug. 13 for structural concrete work to construct sidewalks on east approach to 3rd st. bridge. J. H Blomshield, secy.

Covington, Ind.—Bids are asked until Aug. 10 for building the Covington viaduct, including one 140-ft. steel bridge, 2 concrete piers, 1 concrete arch, excavating, etc. Co. comrs.

Regina, Sask.—Bids are asked until Aug. 13 for constructing 8 concrete piers and 2 abutments for a traffic bridge over Saskatchewan river. F. J. Robinson, deputy comr. pub. wks

Green Bay, Wis.—Bids are asked until Aug. 7 for erecting a double arch stone bridge in town of Morrison, and a single stone arch bridge in town of Holland. E. S. Hall, co. clk.

Zanesville, O.—Bids are asked until Aug. 13 for altering the substructure of a bridge over South Fork of Jonathan creek on 1st st., Roseville, O. L. E. Brelsford, co. audt.

Paducah, Ky.—This city desires plans, specifications and estimates for an iron bridge, 280 ft. long, 25 ft. average height, 26 ft. carriage way, with 5 ft. sidewalks on each side. L. A. Washington, cy. engr.

New Ulm, Minn.—Sealed bids are asked until Aug. 10 for erecting a 1,200-lb. steel bridge across the Big Cottonwood river at the so-called Leavenworth site. Jesse Palmer, chm. co. comrs.; Louis G. Vogel, co. audt.

Uniontown, Pa.—Bids are asked until Aug. 3 for constructing stone abutments and wing walls for a bridge over George creek in Springhill and Nicholson twps.; also for constructing steel superstructure. Ash F. Williams, clk.

PARKS.

Modesto, Cal.—Land has been offered this city for a park.

Lansing, Mich.—A river front park along the Grand river is contemplated here.

Beverly, Mass.—Town has appropriated $1,500 for the purchase of a new park.

Bristol, Va.—City council voted to purchase a 33-acre grove for a public park.

West Mount, Quebec—Will vote on the issue of $150,000 bonds for establishing parks and public squares.

Eau Claire, Wis.—A 20-acre tract of ground has been presented to this town to be used as a public tract.

STREET LIGHTING.

Alma, Neb.—Voted to issue bonds for an electric light plant.

Lumpkin, Ga.—Voted to issue bonds for erecting an electric light plant.

Potsdam, N. Y.—Voted to issue $24,000 to construct a municipal light plant.

Newton, N. C.—An electric light plant is contemplated. John P. Yount, mayor.

McEwen, Tenn.—L. D. Baker is arranging to establish an electric light plant.

Rockaway, N. J.—Voted to issue bonds for establishing a municipal lighting plant.

Owatonna, Minn.—Council contemplates the establishment of a municipal gas plant.

St. Louis, Mo.—Contracts will be let

Aug. 17 for lighting the city institutions. B. P. L.

Annapolis, Md.—Mayor Douw is in favor of the establishment of a municipal lighting plant.

Benwood, W. Va.—Council is considering the matter of erecting a municipal electric light plant.

Chester, Pa.—Sealed bids are asked until Aug. 6 for lighting the streets. Jas. R. Bagshaw, chmn. lgt. com.

Sauk Rapids, Minn.—Plans have been prepared for a power plant for the Sauk Rapids Power Co., to cost $350,000.

Tremont, Neb.—Will vote Aug. 1 on issue of bonds for constructing an electric light plant. S. F. Stiles, cy. clk.

Saskatoon, Sask.—Bids are asked until Aug. 14 for erecting an electric light and water works plant. Adam Turner, secy. and treas.

Stonebluff, Ind.—Bids are asked until Aug. 4 for a steam heating plant for the Stonebluff schoolhouse. W. B. La Bar, engr., Veedersburg.

Jersey City, N .J.—The Jersey City Light and Equipment Co. has been incorporated by Harry E. Crandall, James J. Farmer and Alexander Michel.

Portsmouth, Va.—Council has authorized the lighting committee to investigate and report on the question of a municipal electric light plant.

Danielson, Conn.—Plans and estimates are being made for extensive alterations and additions to the power house and plant of the People's Light and Power Co.

Kingwood, W. Va.—The electric light plant was destroyed by fire, and the citizens will be asked to vote on the issue of bonds to construct another.

Cameron, Mo.—Will vote Aug. 6 on issue of $4,500 bonds for purchasing and installing new engines and generators at the electric light and water works plants.

Chicago, Ill.—Bids are asked until Sept. 12 for constructing a transformer plant for water power at Western ave. and the channel. Robert R. McCormick, prest. drainage bd.

Lowellville, O.—Sealed bids are asked until Aug. 2 for installing boiler, feed pump engine, dynamo and switchboard at electric light plant. Bd. vil. trustees.

Topeka, Kas.—City council granted a franchise, July 9, to the Topeka Electric Co., for 30 years. The new company must begin construction of its plant in 90 days.

Dixfield, Me.—The Dixfield Light and Improvement Co. has been organized to manufacture and deal in gas and electricity for lighting, heating and manufacturing purposes. L. J. Coleman, prest.

Williston, N. D.—Bids are asked until Sept. 10 for installing 3 transformers and 8 motor-driven pumping units in pumping stations near Buford, N. D. H. A. Storris, engr., Williston.

Hamilton, O.—Council adopted a resolution, July 10, to call a special election to decide the question of issuing $225,000 bonds for enlarging and improving the gas, electric light and water plants.

Washington, Pa.—The Franklin-Washington Gas Co. has been incorporated and will supply consumers in West Washington, Houston, Canonsburg and McDonald. W. F. Borches, of this city, is president of the company.

Mobile, Ala.—Bids are asked until Aug. 10 for furnishing electric lights for 5 and 10 years; also for erection and operation of a 600-light plant for 10 years, based on municipal ownership after that time. Pat J. Lyon, mayor.

Kenosha, Wis.—City council has received estimates from the consulting engineers on the cost of municipal lighting plant for this city, who place the cost of a 300-arc light plant at $41,333.30, and annual cost of operation at $8,341.

Louisville, Ky.—The board of public works will sell, Aug. 17, a franchise for stringing wires for the sale of electricity along the streets, alleys and other public places, and constructing necessary conduits and manholes and erecting poles for the installation of such wires. Roger G. McGrath, secy. B. P. W.

Montgomery, Ala.—The stockholders of the Citizens' Light, Heat and Power Co. have organized a corporation under the name of the Citizens' Light and Power Co. The change was made to take advantage of the new corporation laws of Alabama, which are liberal. The enlargement of the plant and extension of the service is contemplated.

Jersey City, N. J.—The Zanzibar Electric Light Co. was incorporated, July 11, and proposes to erect and maintain a plant on the island of Zanzibar, Africa, for the generation and distribution of electric current for heat, light and power. B. S. Mantz, Thos. F. Barrett and Felix Ingold, all of 15 Exchange Place, Jersey City, are the incorporators.

GARBAGE DISPOSAL, STREET CLEANING AND SPRINKLING.

Temple, Tex.—City is considering the establishment of a garbage crematory.

Chicago, Ill.—The contract for garbage reduction was awarded to Bake, Hall & Christian, at $47,500.

Bloomington, Ill.—The contract for constructing a garbage crematory was awarded to Lewis & Kitchen, of Kansas City, for $12,911.

Little Falls, N. Y.—Edward Dineen was awarded a contract for collecting the garbage from dwelling houses for $495 per year.

Minneapolis, Minn.—Special. The Decarie Manufacturing Company has awarded a contract to the Wm. Bros. Boiler and Manufacturing Co., of Minneapolis, Minn., for the construction of two all steel water jacketed incinerators to be installed at Ocean Park, Cal., and Santa Monica, Cal. The Decarie Manufacturing Company has also awarded a contract to the American Bridge Co., of Minneapolis, Minn., for the construction of two steel buildings, for incinerators, to be erected at Ocean Park, Cal., and Santa Monica, Cal.

Wilmington, Del.—The contract for garbage disposal for 9 years was awarded, July 12, to the Wilmington Sanitary Co., at $33,850 per year. Contracts for collection of garbage for 3 years were awarded at the same time as follows: 1st dist., John H. Thompson, $5,295; 2nd dist., Chas. H. Colburn, $7,831; 3rd dist., Henry Wetsel, $9,376; 4th dist., Daniel McCormick, $18,310.

FIRE APPARATUS.

Oslo, Minn.—Fire department will purchase supplies according to press reports.

Little Falls, Minn.—Council fire committee will purchase 5 dozen rubber coats for the fire department.

Davenport, Ia.—City council voted, July 16, to ask for bids for 1,000 ft. of hose. Cy. Engr. Treichler.